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ABSTRACT

The ocean affects all of our lives. Therefore, awareness of and information about the interconnections between humans and oceans are prerequisites to making sound decisions for the future. Project ORCA (Ocean Related Curriculum Activities) has developed interdisciplinary curriculum materials designed to meet the needs of students and teachers living in Washington State. Each activity packet provides the teacher with a set of lessons dealing with a particular topic related to the oceans. Included are student worksheets, lesson plans, a vocabulary list, and a bibliography. In this unit, designed for the junior high level, students can explore the potential of offshore oil deposits, and proposals for tapping the energy of the tides, winds, currents, and ocean thermal differences. Attention is paid to the economic and environmental impact of exploiting these sources. As our energy situation is a complex one with no clean-cut answers, the activities in this unit are correspondingly open-ended. (TW)



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ED289676

# ENERGY FROM THE SEA

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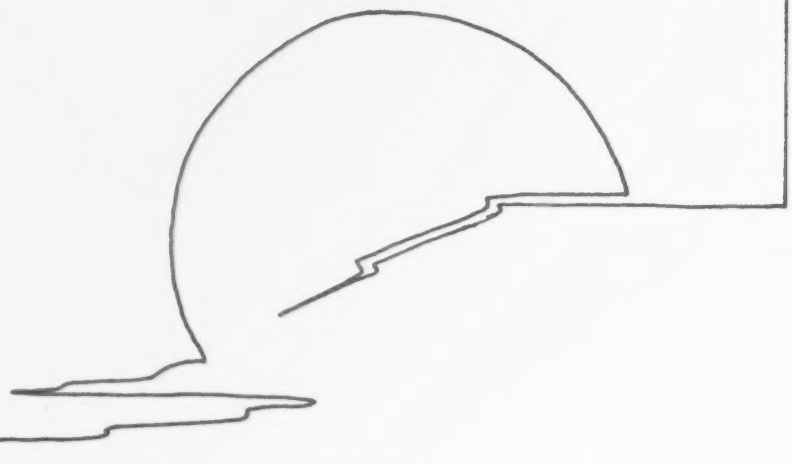

SE 048 761

ORCA

## OCEAN RELATED CURRICULUM ACTIVITIES

PACIFIC SCIENCE CENTER / SEA GRANT
MARINE EDUCATION PROJECT

CLAIRE JONES, AUTHOR
ANDREA MARRETT, MANAGER

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ORCA PUBLICATIONS

ELEMENTARY

High Tide, Low Tide (4th Grade)
Life Cycle of the Salmon (3rd - 4th Grade)
Waterbirds (4th - 5th Grade)
Whales (4th - 6th Grade)

JUNIOR HIGH

Beaches
Beach Profiles and Transects
Early Fishing Peoples of Puget Sound
Energy from the Sea
Literature and the Sea
Tides
Tools of Oceanography

SENIOR HIGH

American Poetry and the Sea
Marine Biology Activities
Marine Biology Field Trip Sites
Marshes, Estuaries and Wetlands
Squalls on Nisqually: A Simulation Game

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# PROJECT ORCA

The ocean? It's 2 miles away; it's 200 miles away; it's 2000 miles away. What does it matter to me? For those students who live close to the ocean, a lake or a stream, the effect of water might be more obvious. For the student who lives on a wheat farm in the arid inlands, the word ocean is remote. It may conjure up images of surf, sand and sea gulls, experiences far removed from their daily lives; or it may have no meaning at all. Yet for that same youngster, the reality of the price of oversea wheat shipments or fuel costs for machinery are very real. The understanding of weather and its effects on the success or failure of crops is a basic fact of everyday life. The need for students to associate these daily problems with the influence of the marine environment exists. It requires exposure to ideas, concepts, skills and problem solving methods on the part of the youngsters. It also requires materials and resources on the part of our educators.

The goals of ORCA (Ocean Related Curriculum Activities) are: 1) to develop a basic awareness of ways in which water influences and determines the lives and environments of all living things; and 2) to develop an appreciation of the relationship of water to the study of the natural sciences, social sciences, humanities and the quality of life.

ORCA attempts to reach these goals by: 1) developing interdisciplinary curriculum materials designed to meet the needs of students and teachers living in Washington State, 2) developing a marine resource center, and 3) providing advisory services for marine educators. In conjunction with these efforts, ORCA is coordinating communication among educators throughout the state and the rest of the nation.

The curriculum materials are developed to be used in many areas including the traditional science fields. They consist of activity packets which fit existing curricula and state educational goals and are designed for use as either a unit or as individual activities.

The ocean affects all our lives and we need to be aware and informed of the interconnections if we are to make sound decisions for the future of the earth, the ocean and our own well being. We hope that through Project ORCA, teachers will be encouraged to work together to help students understand and appreciate the ocean and the world of water as a part of our daily existence.

# ACKNOWLEDGEMENTS

The Ocean Related Curriculum Activities (ORCA) are a product of a cooperative effort. These materials were developed at the Pacific Science Center. Assistance was provided by the National Oceanic and Atmospheric Administration (NOAA) Sea Grant held by the University of Washington. The Office of the Washington State Superintendent of Public Instruction provided technical support and assistance.

## TRIAL TEACHERS

Trial teachers test us and answer the most important question of all: "Does it work?" The teachers who gave their time, effort and advice were:

Lynda Hughes and Allen Husker, Edmonds School District
Lee Boulet; Highline School District
Barbara Deihl and Susan Swenson; Kent School District
Andrea Marrett; Lake Washington School District
Claire Jones and Jenifer Katahira; Pacific Science Center School for Science
Greg Aveleson, Joe Budde and Mary Ketcham; Renton School District
Margaret Bonham, Ivan Ellis, Willim Lippit, Barb Norsen and Jay Sasnett; Seattle School District

## CONSULTANTS

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Dennis Campbell, Teacher, Edmonds School District
Alyn Duxbury, Ph.D., Assistant Director for New Programs, Division of Marine Resources, University of Washington
Charles J. Flora, Ph.D., Director of Aquatic Studies, Western Washington University
Charles Hardy, Coordinator, Math and Science, Highline School District
Richard Sternberg, Ph.D., Department of Geology, University of Washington

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Pam Phillips, Program Assistant, Pacific Science Center
Ann Sankey, Manager of Elementary Programs, Pacific Science Center
Elizabeth Sears, Biology Teacher, Edmonds School District
Jan Turnbull, Environmental Education and Energy, Shoreline School District
Beverly Williams, Education Intern, Pacific Science Center

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Sally Snyder, Ph.D., Anthropologist
Hilary Stewart, Author
Jerry Strain and Joel Rogers, Photographers
Terry Taffoya, United Indians of All Tribes

## ADVISORY COMMITTEES

The Marine Education project was reviewed annually by the Sea Grant Site Evaluation committee. We thank them for their advice and support.

Continuing guidance for the program direction was provided by the Pacific Science Center Education Committee, the members of which are:

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Levon Balzer, Ph.D., Dean of Instruction, Seattle Pacific University
Charles Hardy, Coordinator, Math and Science, Highline School District
David Kennedy, Supervisor of Science and Environmental Education; Office of Superintendent of Public Instruction
Roger Olstad, Ph.D., Associate Dean of Graduate Studies, University of Washington, Committee Chairperson
Alice Romero, Teacher, West Seattle High School
Sally Stapp, Teacher, Frank Wagner Elementary
William Stevenson, Superintendent, Shoreline School District

## STAFF

Finally, our heartfelt appreciation to the staff members who were instrumental in creating, developing and supporting this project. Thank you to the curriculum writers Jenifer Katahira, Claire Jones, Andrea Marrett, Florence Sands and Sally Snyder. We appreciate the efforts of the people responsible for graphics and paste up; Susan Lundstedt, graphics; Luann Bice, artwork; Valene Starrett, covers; and Andrea Marrett and Carolyn Hanson, paste up. We sincerely thank our project investigator, Bonnie DeTurck, Director of Education and Debbie Fowler, the Marine Education Intern at the Pacific Science Center. We wish also to express our gratitude to Patty Kelley, Jan McLachlin, Leslie Wozniak and Peggy Peterson, for their patience in typing, retyping and alas, typing it all over one more time.

A special thanks to my husband, John Pauls, for all the moral support he provided during the development of these materials and his idea-generating questions.

Shirley Pauls
Project Manager
September 1977 to February 1979

For current information of project activities and/or materials, contact:

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Seattle, WA 98109

# ENERGY FROM THE SEA



**ABSTRACT:** It has recently become apparent that at the present rate of usage, the fossil fuels we use for energy will not last through the next century. Conservation of existing sources and development of new sources and technologies are our only hope for the future. The oceans constitute more than seventy percent of the earth's surface; therefore, it is logical to look to the marine environment for future energy sources. In this unit, students will explore the potential of offshore oil deposits, and proposals for tapping the energy of the tides, winds, currents, and ocean thermal differences. Attention is paid to the economic and environmental impact of exploiting these sources. As our energy situation is a complex one with no clean-cut answers, the activities in this unit are correspondingly open-ended. You and your students are asked to think about the issues, not to memorize facts.

**SUBJECT AREAS:** Science, Social Studies

**GRADE LEVELS:** Junior High

**WRITTEN BY:** Claire Jones

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# ENERGY FROM THE SEA

**OBJECTIVES:** The student will be able to:

1. Trace several energy sources to their origins.
2. Explain why we are looking for new energy sources and why the oceans are a good place to look.
3. Define the Law of Diminishing Returns and explain why it is important in searching for and exploiting offshore oil deposits.
4. Name some advantages and disadvantages of drilling for offshore oil.
5. Present arguments for or against local offshore oil drilling from at least two different points of view.
6. Name some renewable and some non-renewable energy sources.
7. Suggest some new idea of his/her group to make energy available.
8. Recognize that some ideas for making energy available may use more energy than they produce or be otherwise impractical.
9. Explain some of the ins and outs of generating power from the tides.
10. Explain what an OTEC is and what some of its advantages and disadvantages are.
11. Name some factors which should be considered in evaluating an energy source.
12. Evaluate an energy source on the basis of those factors.

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Students explore the classroom for oil (stamps) and discover the Law of Diminishing Returns. Student handout on Offshore Oil Drilling is done as an assignment.

**ACTIVITY 3:** DRILLING FOR OIL IN PUGET SOUND (1 DAY) 20

Students stage a simulation of a public hearing and city council decision concerning local offshore oil drilling.

**ACTIVITY 4:** RENEWABLE AND NON-RENEWABLE RESOURCES (1-2 DAYS) 26

Students discover and identify renewable and non-renewable resources.

**ACTIVITY 5:** BRAINSTORMING WITH DIPPING BIRDS AND RUNNING CATS (1-2 DAYS) 30

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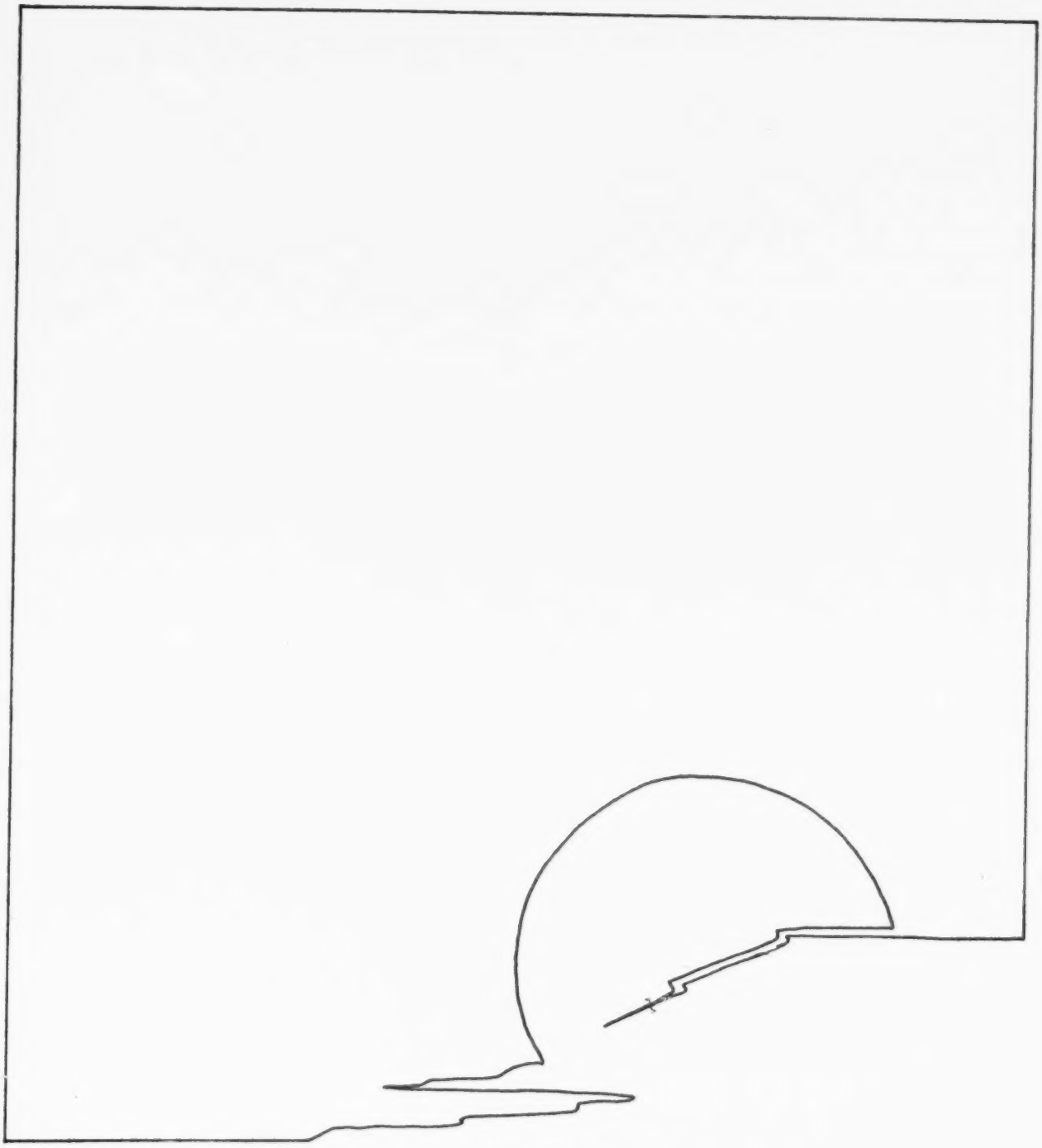
**ACTIVITY 6:** ENERGY FROM THE SEA - ALTERNATIVES (1-2 DAYS) 36

Two current suggestions for alternative energy systems are studied and advantages and disadvantages of both are weighed. Student handouts are on "Tidal Generation" and "Ocean Thermal Energy Conversion."

**ACTIVITY 7:** ENERGY FROM THE SEA (1 DAY) 56

Students evaluate energy sources on the basis of economic, environmental and technological aspects.

**EVALUATION:** **VOCABULARY:** **BIBLIOGRAPHY:** 58



# ACTIVITY 1:
# INTRODUCTION TO ENERGY RESOURCES AND THEIR LIMITS (1-2 days)

# ACTIVITY 1:

# INTRODUCTION TO ENERGY RESOURCES AND THEIR LIMITS (1-2 days)

**CONCEPTS:**

1. The energy sources we are using are running out, and there is need to find new sources.
2. With a few exceptions (i.e., geothermal, tidal, and nuclear power), most energy can be traced to the sun.
3. The earth's oceans are an untapped reservoir of mineral, food, and energy resources.

**OBJECTIVES:**

The students will be able to:
1. Trace several energy sources to their origins.
2. Explain why we are looking for new energy sources and why the oceans are a good place to look.

**TEACHER PREPARATION:**

Suggested teacher reading: "Energy Resource Limits." You may also wish to assign this as reading material for the students.

**MATERIALS:**

Run off one copy per student of Student Handout - "Energy From the Sea - Some Questions."

**PROCEDURES:**

1. Distribute Student Handout, "Energy from the Sea." Explain that these are questions the students should be able to answer after completion of this activity packet.

2. Initiate discussion on energy--our present situation, the sources that are commonly used, the limits of those sources (see backgroun reading for information). Have the students look at a large globe. What percentage is water? *(about 70% water, 30% land)*

3. A large amount of the radiant energy that leaves the sun is lost in space. Of the solar radiation that reaches the earth, how much falls on the land as compared to the oceans? *(about 1/3 or 30%)*. Lead the class in a discussion of energy origins and uses.

   A. What happens to the solar radiation that strikes the land? *(A small amount is converted by plants into food and can be used by animals and man. Oil, gas, and coal are created from plants and may be used for fuel)*

   B. What happens to the solar energy striking the oceans?
      1. *It warms the top layers of water, especially in tropical areas, causes evaporation which creates clouds and forms our weather patterns, causing winds, waves, and currents.*
      2. *Our hydroelectric power can be traced to the constant supply of water from evaporation of the oceans.*
      3. *Much is also converted into plant and animal matter by ocean life.*

4. Bring students to the conclusion that the oceans are a tremendous reservoir of stored solar energy.

**EXTENDED ACTIVITIES:**

1. Start a bulletin board for information and current clippings concerning energy and the sea.
2. Films: The Restless Sea

   Energy: A First Film - 8 minutes. BFA
   Educational Media
   2211 Michigan Avenue
   Santa Monica, California 90404

   Energy: Choices, Options, Decisions
   Screen News Digest
   235 East 45th Street
   New York, N.Y. 10017

3. An energy crossword puzzle is available from the National Atomic Museum, Albuquerque, New Mexico - or have students make up their own crossword puzzle.

**BIBLIOGRAPHY:**

Ehlich, Paul et. al, Ecoscience, p. 403, 1977.
Oceanus, Volume XVII, Summer 1974, Woods Hole Oceanographic Institution. The entire issue is articles dealing with energy and the sea.

Student Handout

NAME _____

DATE _____

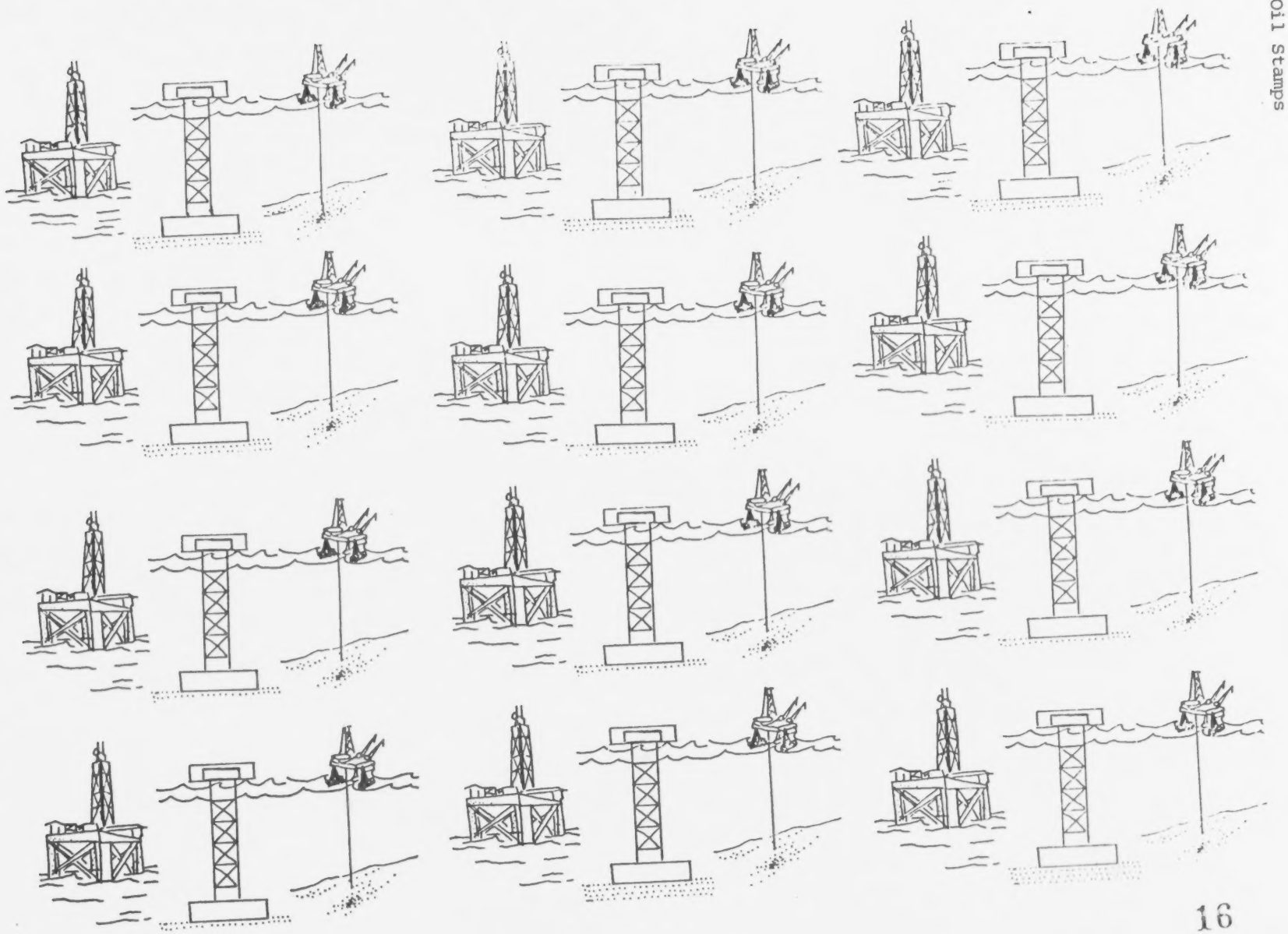
PERIOD _____

ENERGY FROM THE SEA - SOME QUESTIONS

Questions you should be able to answer at the end of the unit:

Can you:

1. Trace a few of the energy resources we use to their sources?
2. Explain why we are looking for new energy sources, and why the oceans are a good place to look?
3. Define the "Law of Diminishing Returns," and explain why it is important in searching for and exploiting offshore oil deposits?
4. Name some advantages and disadvantages of drilling for offshore oil?
5. Name some renewable and some non-renewable energy sources?
6. Name some new and different ideas under the sun to make energy availabe to people?
7. Suggest some new idea of your own?
8. Explain some of the ins and outs of generating power from the tides?
9. Explain what an OTEC is and what some of its advantages and disadvantages are?
10. Name some factors which should be considered in evaluating an energy source.



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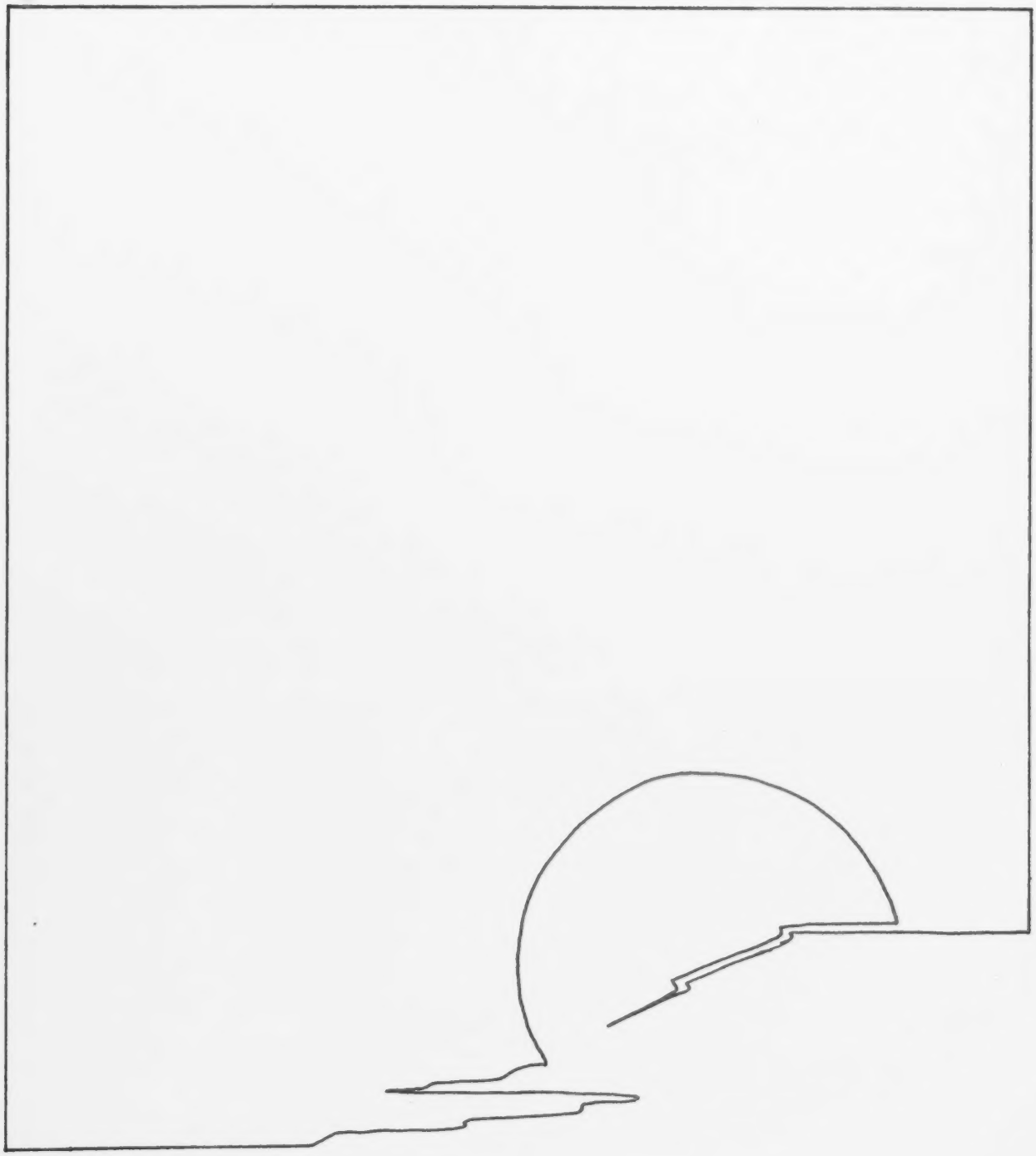


# ACTIVITY 2:
# DRILLING FOR OIL IN THE CLASSROOM
# (1-2 days)

# ACTIVITY 2: DRILLING FOR OIL IN THE CLASSROOM (1-2 days)

**CONCEPTS:**

The Law of Diminishing Returns states that: "As a resource is used up, it takes more time and energy per unit to utilize what remains."

There are many trade-offs involved in exploitation of offshore oil:

1. Possible pollution
2. Independence from foreign oil
3. Employment for American workers

**OBJECTIVES:**

The student will be able to:
- define the Law of Diminishing Returns and explain why it is important in searching for and exploiting offshore oil deposits.
- name some advantages and disadvantages of drilling for offshore oil.

**TEACHER PREPARATION:**

Oil stamps - copy and cut out enough for 10 per student, and hide in various accessible and inaccessible places in the classroom before class.

Student Handout - "Offshore Oil" -- make 1 copy for each student.
Teacher's copy of Student Handout - "Offshore Oil"

**PROCEDURES:**

Before students come into the classroom, put oil stamps out in various accessible and inaccessible places. At the start of the lesson, explain that the stamps represent an energy source, such as oil, which they are to search for and use as they wish. Have students search for ten minutes.

Questions for discussion:
1. How many were found?
2. Do you think you found all there were?
3. How do you know?
4. How easy was it to find the stamps as time went by?

Compare this search for stamps to the search for new oil deposits. The remaining oil reserves on earth are more difficult to reach, and more energy must be used to find them than in the past. Discuss the Law of Diminishing Returns and its implications.

**ASSIGNMENT:**

Distribute Student Handout - "Offshore Oil". Have the students read and complete this handout for the next class session.

At next class session discuss the positive and negative aspects of offshore oil drilling. (See teacher's copy of worksheet as well as suggested sources for more information.)

**EXTENDED ACTIVITIES:**

1. Peanuts for Oil - Use peanuts instead of oil stamps, being careful to keep students' interaction focused on the peanuts as a symbol of an energy source. Discussion could naturally arise out of the possible "mess" in the environment when the peanut source is exploited. Peanuts for Peanuts: to get a sense of the economics involved, put a price on the peanuts - which rises as the supply of accessible peanuts goes down.

Or oil stamps could be traded in for a number of peanuts whose value is tied to the supply of oil stamps. What other improvisations on this activity can you think of to bring out another aspect of energy exploration and economics?

2. Do some experiments on removing oil from water and recovering oil from oil wells (COAST materials packet #316, page 5.)

3. Research effects of oil spills - the Coalition Against Oil Pollution would have good information.

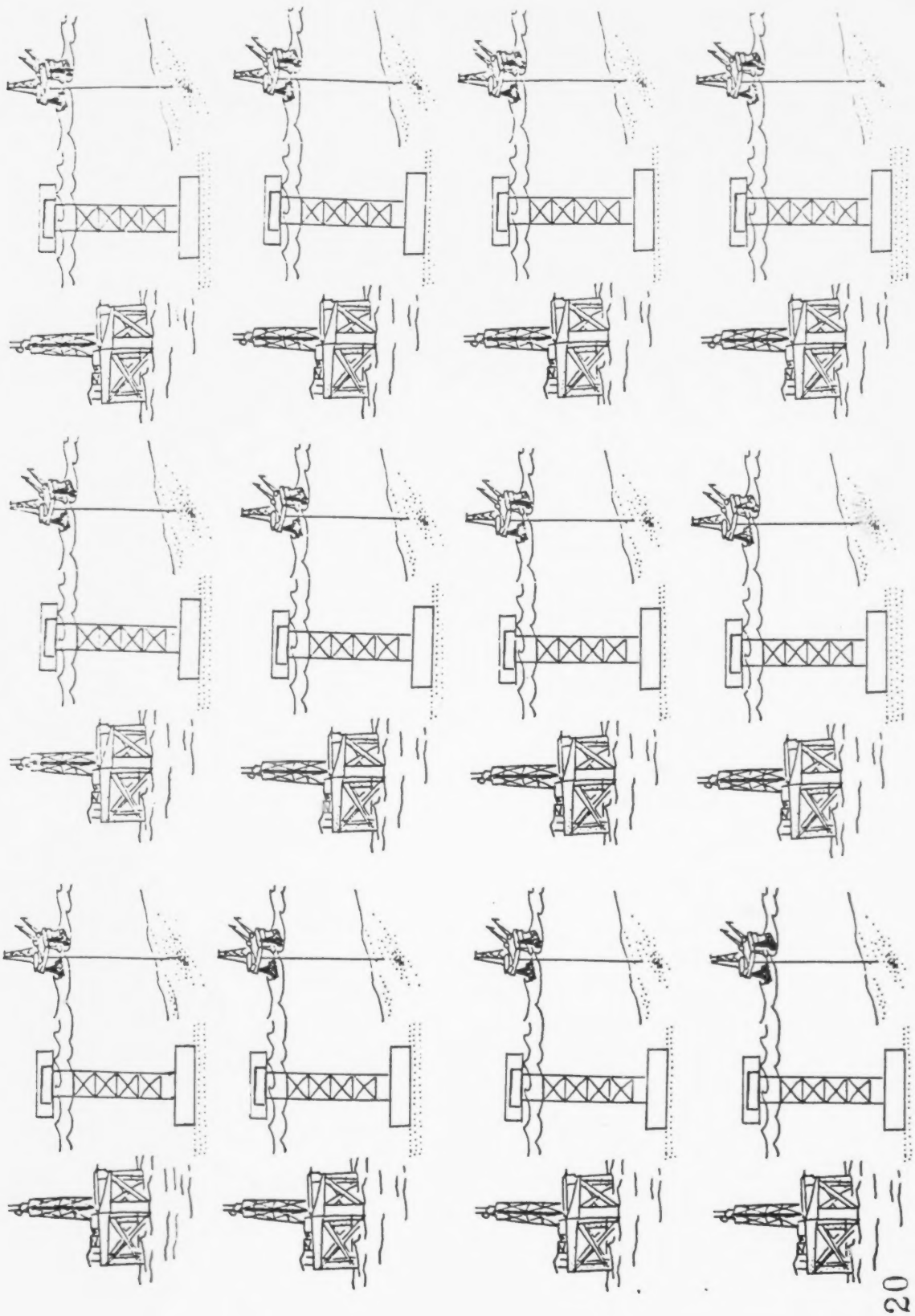
**BIBLIOGRAPHY:**

Ahern, W.R. Oil and the Outer Coastal Shelf: The Georges Bank Case. Ballinger Publishing Company: Cambridge, Massachusetts, 1973.

Becker, Mary Kay and CoBurn, Patricia. Super Spill. Madrona Press: Seattle, Washington, 1974.

C.O.A.S.T. (Coastal Oceanic Awareness Studies). University of Delaware: Neward, Delaware. #316 Where Will Oil Come From Next?

Oil Stamps



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TEACHER INFORMATION SHEET

## OFFSHORE OIL

The increasing use of oil in this country and our growing dependence on imported oil has stimulated a search for new sources of energy as well as attempts by Americans to conserve energy. One result has been the discovery of large oil reserves off the coasts of the country. It has been estimated that the Continental shelf may contain 160 to 200 billion barrels of oil.* The cost of offshore drilling is high, however. It costs seven times as much to recover oil offshore as it does for drilling inland.

1. If this is true, why are some people advocating offshore drilling instead of importing oil from foreign countries?

   *Transportation costs are great for imported oil. Domestic oil prices may be competitive even if the offshore drilling process is more expensive.*

   *Many Americans fear dependence on foreign oil.*

2. This cartoon suggests a possible effect of drilling for oil offshore. What does it say to you?

   *Anything acceptable.*

DAILY NEWS, Tuesday, January 4, 1977

3. What other advantages and disadvantages of offshore oil drilling can you think of?

| Advantages | Disadvantages |
|---|---|
| *Employment for American workers* | *Oil spills & leaks cause pollution* |
| *Independence from foreign sources* | *Mineral rights questionable* |
| *Other oil sources running out* | *Pipelines & supertankers controversial* |
| *Unknown effects on marine environments* | *Many people consider derricks unsightly* |
| *Natural disasters* | *Unknown effects on marine environments* |
| | *Natural disasters, such as earthquakes, volcanoes, may free the oil at some time in the future* |
| | *Expensive* |
| | *Noise Pollution* |
| | *Interferes with recreation* |

* COAST 316, page 8

STUDENT HANDOUT

NAME_____

DATE_____

PERIOD_____

# OFFSHORE OIL

The increasing use of oil in this country and our growing dependence on imported oil has stimulated a search for new sources of energy as well as attempts by Americans to conserve energy. One result has been the discovery of large oil reserves off the coasts of the country. It has been estimated that the continental shelf may contain 160 to 200 billion barrels of oil.* The cost of offshore drilling is high, however, It costs seven times as much to recover oil offshore as it does for drilling inland.

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*COAST 316, page 8

DAILY NEWS, Tuesday
January 4, 1977

STUDENT HANDOUT

OFFSHORE OIL (cont'd)

NAME_____

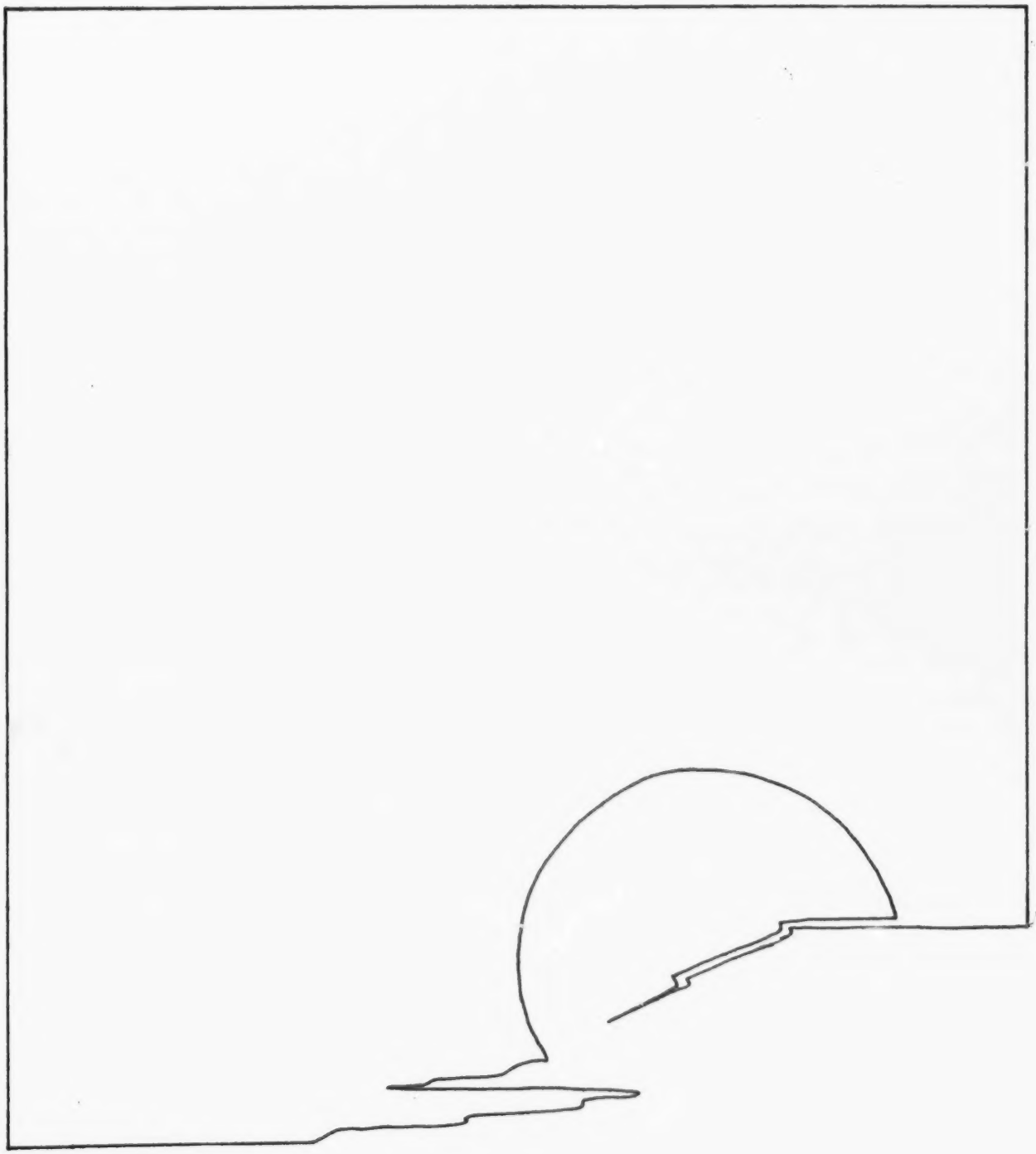
DATE_____

PERIOD_____

3. What other advantages and disadvantages of offshore oil drilling can you think of?

Advantages:

Disadvantages:



# ACTIVITY 3:

# DRILLING FOR OIL IN PUGET SOUND

# (1 day)

# ACTIVITY 3: DRILLING FOR OIL IN PUGET SOUND (1 day)

**CONCEPTS:**

1. Offshore oil drilling can be a very controversial issue in a given location.
2. Attitudes of citizens toward offshore oil drilling may be affected by their occupations, investment and recreational interests.
3. Decision-making about issues concerning public resources should be based on information input from as many points of view as possible.

**OBJECTIVES**

The student will be able to:
- present arguments for or against local offshore oil drilling from at least two different points of view.

**TEACHER PREPARATION:**

Suggested teacher reading: "Edmonds City Council Resolution #226." Make available to students a variety of resources, as listed on next page.

**MATERIALS:**

Variety of Resource Materials

**PROCEDURES:**

Stage a simulation of a public hearing and city council decision concerning local offshore oil drilling.

Present this scenario to students: As a concerned citizen of the coastal town of Waterdale, you have heard that the state is considering leasing land under Blunderphuss Sound to oil companies for exploratory oil drilling. Your waters are known nationwide for their purity and recreational value, yet oil, if discovered, could create many new jobs, and possibly help to finance public schooling. What is your reaction?

Each student should have a role, either as a member of the city council or as a person making a statement at the hearing. Be sure many points of view are presented: conservation-minded citizens, fishermen, ecologists, oil company representatives, state and city officials, owners of property fronting on the water, and those interested in boosting the local economy. These witnesses do not vote, but try to persuade the three council members to vote in their favor. One student would be the chairperson of the council, and preside (hopefully impartially!) over the hearing. The chairperson does not vote. The three council members may or may not have their own biases prior to the hearing, and they may or may not be susceptible to different interest groups. (Students may get a taste of decision-making based on fair representation or they may get a taste of downright bribery.) After everyone has had a say, the city council should vote to reach a decision; i.e., oil drilling is allowed, or allowed with strict controls, or banned outright.

After the simulation is completed, tell the students that this situation actually occured in 1970 in Puget Sound. Enclosed is a copy of the resolution passed by the City Council of Edmonds, Washington, on May 19, 1970. The reaction of many other Puget Sound communities was similar.

**EXTENDED ACTIVITIES:**

1. Do a full-scale simulation about the offshore oil drilling issue. See Award Winning Energy Education Activities, page 18, "Black Gold". Energy Research and Development Association. Helen H. Carly. ed. EROA Technical Information Center: P.O. Box 62, Oak Ridge, Tennessee 37830.

2. Do a case study of the supertanker port issue in Washington State. Why are many residents of Port Angeles opposed to having an oil superport there?

3. Here's a film presenting an oil company's point of view about the effect of offshore oil rigs: "The Steel Reefs", 28 minutes. Available from Chevron film library, 915 N.W. 19th Avenue, Portland, Oregon 97209

4. The Burke Museum at the University of Washington in Seattle has core samples that were taken offshore at Edmonds while engineers were testing for oil deposits. Your students might be interested in visiting the museum to see these.

**BIBLIOGRAPHY:**

For more information concerning the issue over drilling in Puget Sound, students can look up articles in the Seattle Times for May, 1970.

Standard Oil Company of California. Offshore: The Key to Greater Energy Independence. Standard Oil Company of California: Room 1165, 225 Brush Street, San Francisco, California 94014. (Check other oil companies for similar information.)

Shilstone, Beatrice and Arthur, The First Book of Oil, New York, Watts, 1969.

Grove, Neil, "Oil: The Dwindling National Treasure", National Geographic, 145:6, June 1974, pp. 792-825.

Teacher Information

Edmonds City Council
RESOLUTION NO. 125
(page 1 of 2)

A RESOLUTION OF THE CITY OF EDMONDS, WASHINGTON REQUESTING THE STATE LAND COMMISSIONER, THE STATE DEPARTMENT OF NATURAL RESOURCES AND THE STATE BOARD OF NATURAL RESOURCES TO WITHOLD ANY ACTION GRANTING LEASES OR DRILLING PERMITS ON THE STATE LAND UNDER OR ADJACENT TO PUGET SOUND FOR OIL AND/OR GAS DRILLING, EXPLORATION AND/OR DEVELOPMENT PENDING PROMULGATION OF STATE AND LOCAL POLICIES GUARANTEEING PROTECTION OF FISH, GAME, MARINE ECOLOGY, RECREATION AND THE AESTHETIC RESOURCES OF PUGET SOUND AND ITS IMMEDIATE ENVIRONS.

WHEREAS, Puget Sound is unmatched as a natural asset of tremendous business, sociological, and environmental value to the entire State of Washington as well as the communities bordering on it, specifically including the City of Edmonds; and

WHEREAS, residents of the City of Edmonds and immediately contiguous areas have registered great alarm and concern to officials of the City of Edmonds concerning the announcement that the state off-shore lands are being considered for utilization of oil and/or gas exploration, drilling and/or development; and

WHEREAS, the water quality of Puget Sound is the responsibility of all persons and jurisdictions contiguous to that body of water; and

WHEREAS, no amount of money could restore the loss of substantial areas of Puget Sound if the marine ecology were accidentally damaged notwithstanding the best of intentions and utilization of the highest of presently existing safety standards which have massively failed off the shores of Louisiana, California and Alaska; now, therefore,

IT IS HEREBY RESOLVED BY THE CITY COUNCIL OF THE CITY OF EDMONDS, WASHINGTON, AS FOLLOWS:

1. Until adequate safeguards to prevent environmental damage due to normal seepage and/or accidental spillage have

been proven actually to exist over a period of time through practical application and operation in other areas not so susceptible to damage as is the relatively closed body of water, Puget Sound, the hereinafter referred to state agencies should entirely refrain from granting of oil and/or gas leases or permits for exploration, drilling, or development in the waters of Puget Sound or in upland areas which may in any way lead to inadvertent contamination of said Puget Sound.

2. The City Clerk is hereby ordered to send certified copies of this Resolution to the following state agencies and offices:

(a) State Land Commissioner, Honorable Bert Cole;

(b) State Department of Natural Resources; and

(c) The State Board of Natural Resources.

3. The City Clerk is hereby ordered to send a certified copy of this Resolution to the Honorable Jack Metcaf, the Honorable Dale E. Hoggins and the Honorable Bill Kiskaddon, and by so doing the City Council hereby requests that they introduce and urge passage of protective legislation at the next meeting of the Washington State Legislature, including criteria for the State Land Commissioner and Department of Natural Resources to utilize state lands for the highest and best use of the residents of the State of Washington with direct monetary return to the State as only one of the many significant criteria.

RESOLVED this 19th day of May, 1970.

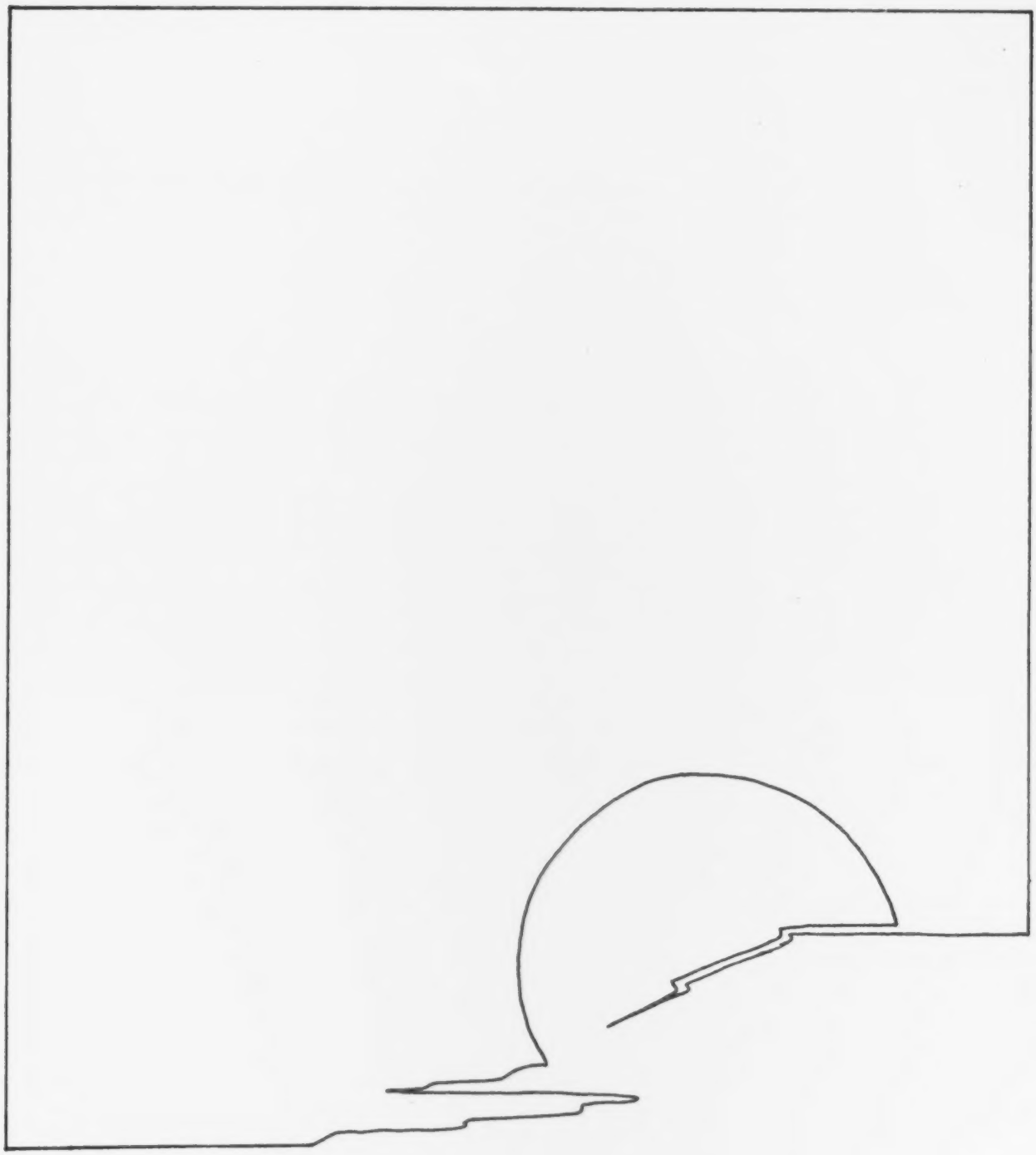
APPROVED:

Mayor

ATTEST:

City Clerk

Filed with the City Clerk: May 19, 1970



# ACTIVITY 4:

# RENEWABLE AND NON-RENEWABLE ENERGY SOURCES (1-2 days)

# ACTIVITY 4:
# RENEWABLE AND NON-RENEWABLE ENERGY SOURCES (1-2 days)

**CONCEPTS:**

Renewable resources are those that do not deplete a fuel and can be used over and over. Examples:

- solar power
- wind
- ocean currents
- geothermal
- tidal power
- hydroelectric
- ocean thermal
- wood

Non-renewable resources are all fuels of which there is a fixed stock.

- oil
- coal
- natural gas
- nuclear

The oceanic tides, currents, winds, and solar radiation are all potentially utilizable renewable energy sources.

**OBJECTIVES:**

The students will be able to:
- name some renewable and some non-renewable energy sources.

**TEACHER PREPARATION:**

Oil stamps - run off enough for 10 per student or use those remaining from Activity 2. Teacher may wish to review background information "Energy Resource Limits."

**MATERIALS:**

Oil Stamps - 10 per student.

**PROCEDURES:**

1. Repeat the oil stamp activity, but this time each stamp is to be replaced and "utilized" again by others. Have the students keep track of how many they find and where. (Also see Additional Learning Activities, #5 - "Peanuts for Peanuts")

2. Discussion: Does it take any more expense of time or energy to "relocate" the stamps?

   What energy sources can the students think of that do not get used up?

3. Write these energy sources on the board and ask students to identify which are <u>renewable</u> and <u>non-renewable</u>.

| | |
|---|---|
| coal | hydroelectric |
| tidal power | ocean currents |
| oil | nuclear |
| geothermal | wood |
| solar | wind |
| ocean thermal | natural gas |

Have students suggest forms of energy in the oceans. Movements of the tides, currents, temperature differences, solar and wind power may all be mentioned. Trace each to its ultimate source; gravitational forces are responsible for the tides, and solar energy drives currents and winds and creates differences in temperatures. (Refer to Pacific Science Center activity packet, "Tides" for scientific background.) Can they identify which are renewable and which are non-renewable? (Those mentioned above are all renewable.)

**ACTIVITIES:**

1. You may wish students to study each energy source a little more fully - library research reports might be a good way to go about it.

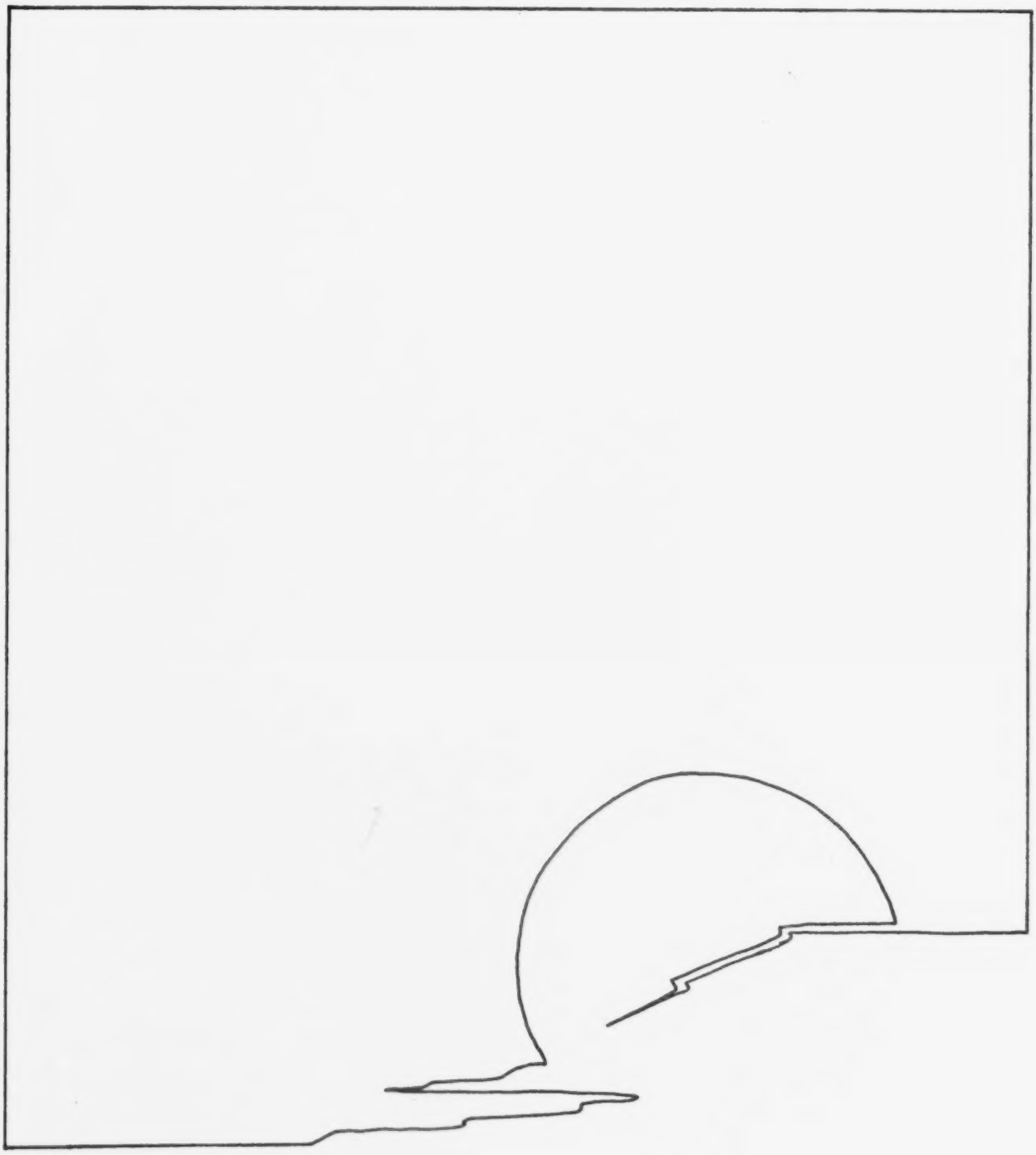
**BIBLIOGRAPHY:**

Mattison, Man and His Resources in Today's World, Mankato, Minnesota, Creative Educational Society, 1967.

Special Report on Energy, National Wildlife, Oct.-Nov. 1974.

Hammond, et al., Energy and the Future, AAAS, 1973. Washington, D.C.

"Energy and Power", Scientific American, September 1971, entire issue.



# ACTIVITY 5:

# BRAINSTORMING WITH DIPPING BIRDS AND RUNNING CATS (1-2 days)

# ACTIVITY 5:
# BRAINSTORMING WITH DIPPING BIRDS AND RUNNING CATS (1-2 days)

**CONCEPTS:**

1. Many processes go on in the earth's oceans that are potentially tappable energy sources. Some are: ocean currents, winds, waves, tides, temperature and salinity differences.
2. Creative thinking about energy usage is needed from our citizens as well as our scientists, inventors, and technologists to help ease the energy crunch.

**OBJECTIVES:**

The student will be able to:

1. Suggest some new ideas of his/her group to make energy available.
2. Recognize that some ideas for making energy available may use more energy than they produce or be otherwise impractical.

**TEACHER PREPARATION:**

Make transparencies of "Dipping Bird" and "Cat Provides Kilowatts".

**MATERIALS:**

Pencils and paper

**PROCEDURES:**

Show picture of transparency of "Dipping Bird" with the comment that it is one person's solution to the energy crisis.

(The bird is a giant version of a toy commonly sold which continues to dip up and down once you start it by pressing its beak into a glass of water. Perhaps a large enough bird of this type positioned on the shore of Puget Sound could, by its motion, generate enough electricity for the entire region.)

Ask your students to think of their own ideas to get power from the oceans. Their ideas can be as impractical as a huge dipping bird or as ridiculous as a cat trying to avoid waves on a beach. (Show cat-power picture.)

What processes go on in the oceans that might be tappable for their energy? (Ocean currents, winds, waves, tides, pressure) What would you do with the energy you tapped?

Your students may feel at a loss if they can't come up with a good idea right away. Emphasize the creative aspect; any idea they come up with is great because it's their own. The purpose of this activity is not to come up with logical answers, but to encourage creative thinking on the students' parts. It may help them to realize that it will take much creative thinking by scientists and technologists as well as themselves to come up with ways to ease our energy shortages.

If your students are still feeling frustrated or blank, here are some "seed" ideas. Don't throw them out all at once, but one at a time, as needed. They are not "assignments", though students may pick one or another to work from.

1. There is tremendous pressure the deeper you go in the ocean. Could this be used to drive pistons of some sort?

2. Evaporation takes place constantly at the ocean's surface. Maybe that water could be condensed for an endless supply of fresh water, or that water could drive turbines to generate electricity.

3. Hurricanes unleash a terrific amount of energy. If someone could invent a way to harness that energy, s/he would be a millionaire. Even better would be to identify the conditions under which a hurricane is formed (not fully understood) and channel the energy to useful means.

4. Tidal waves.

5. How about a machine that gets energy from waves on a beach? If 30 different inventors all tried to design such a machine, we'd have 30 different machines. (Maybe you'd like your class to all start with the same idea and see how many different inventions they come up with.)

6. Envision a large wooden weight attached to a winch connected to a turbine. Electricity can be generated when the tide falls and the weight drops. The "alternating current" of the tides can in this way be used to generate direct current!

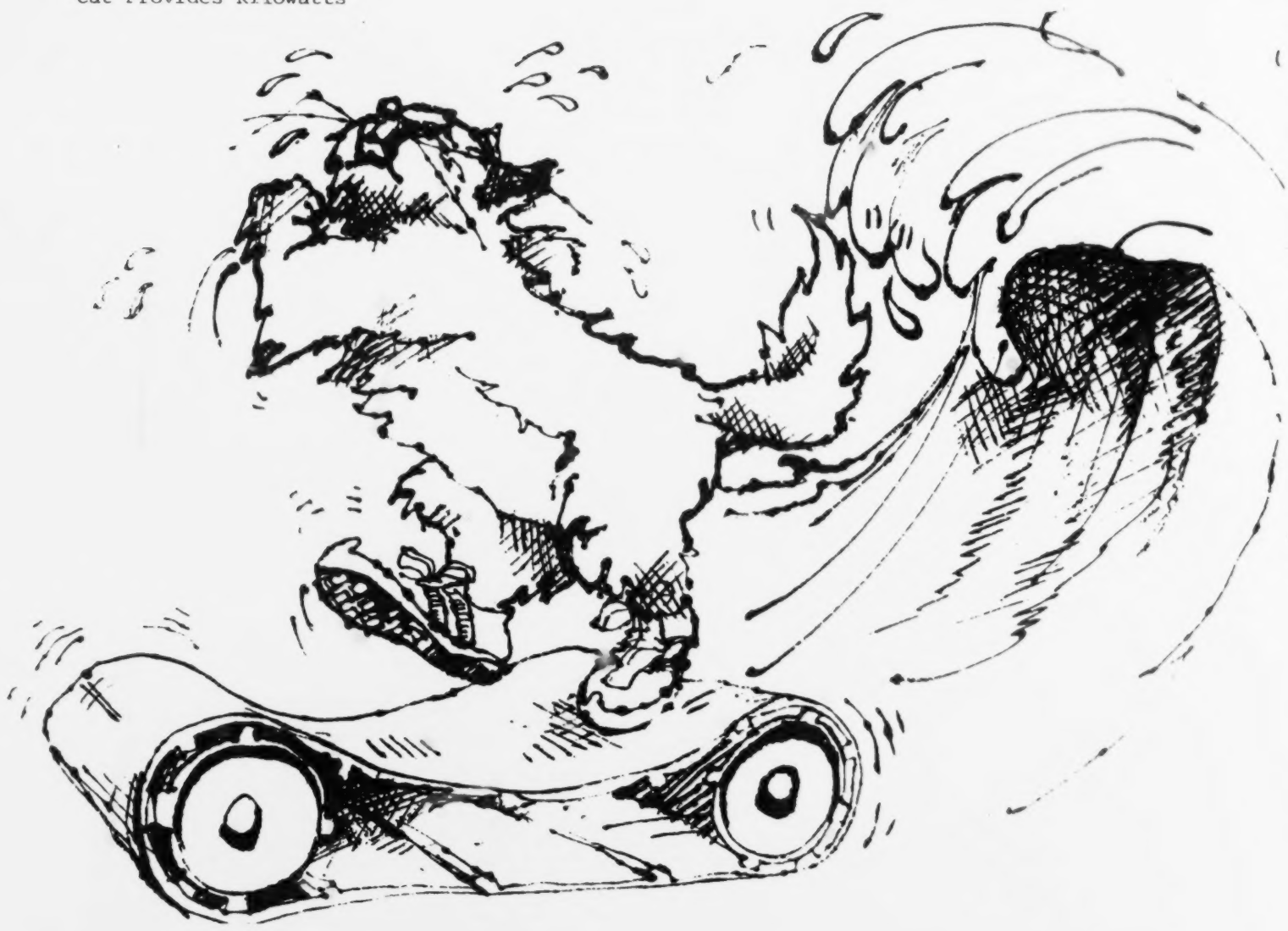
Have students draw schematic diagrams of their own "inventions" tapping ocean power, and share them with the rest of the class.

After the students have shared their ideas, bring discussion to a more serious note. Ask the class if any of their ideas would <u>really</u> work. Have them analyze some of their ideas as to their practicality. Some points to consider might be:

*Would the invention use up more energy than it actually produced?*
*Would materials be too costly for the amount of energy put out?*
*Is the source for energy a dependable one?*

As a closure to the activity, bring out the point that it is difficult to come up with good new ideas, as the students have done. To get these ideas actually working is harder yet, as there are physical laws that must be obeyed, and economic and material restraints.

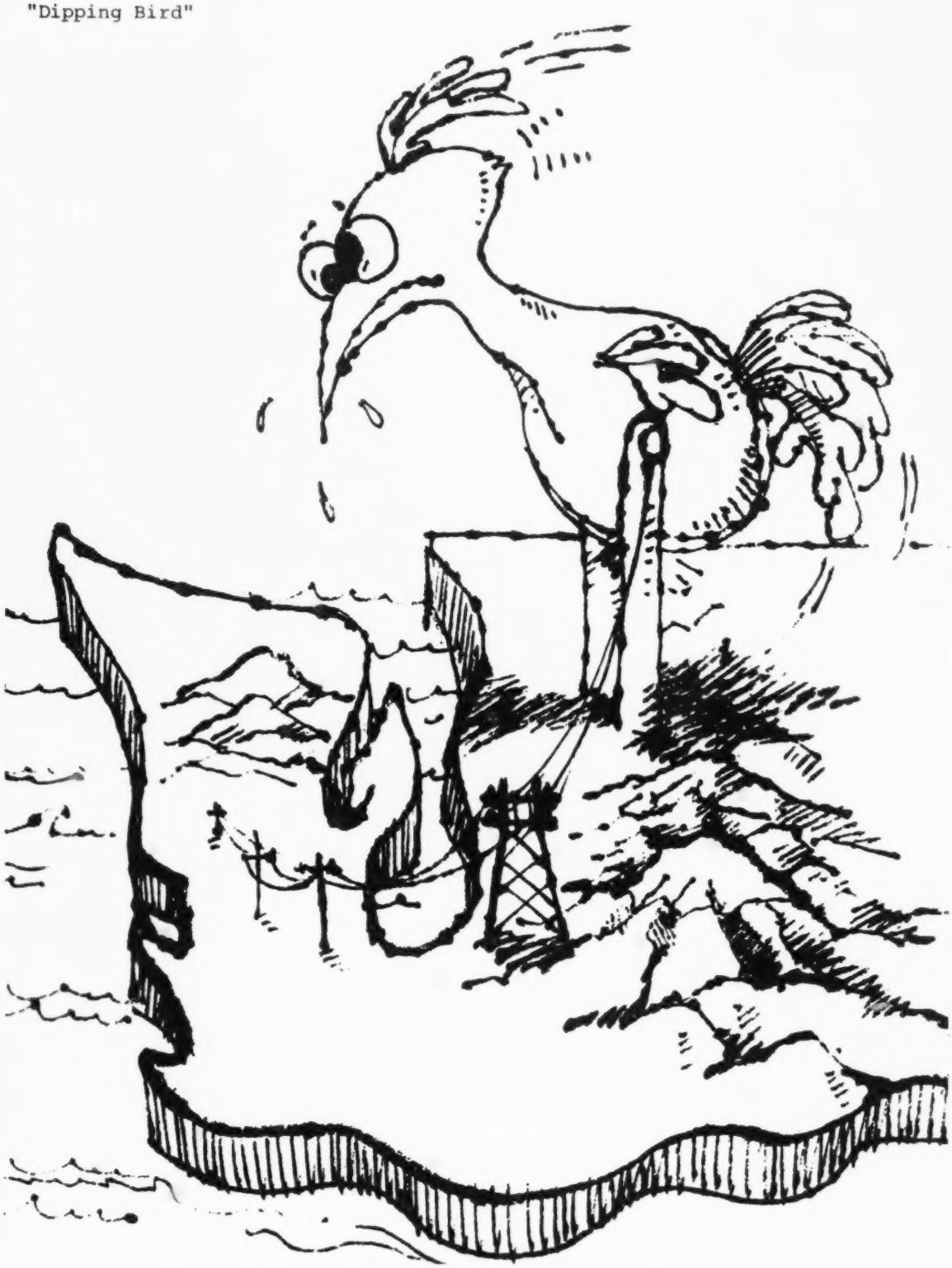
"Cat Provides Kilowatts"



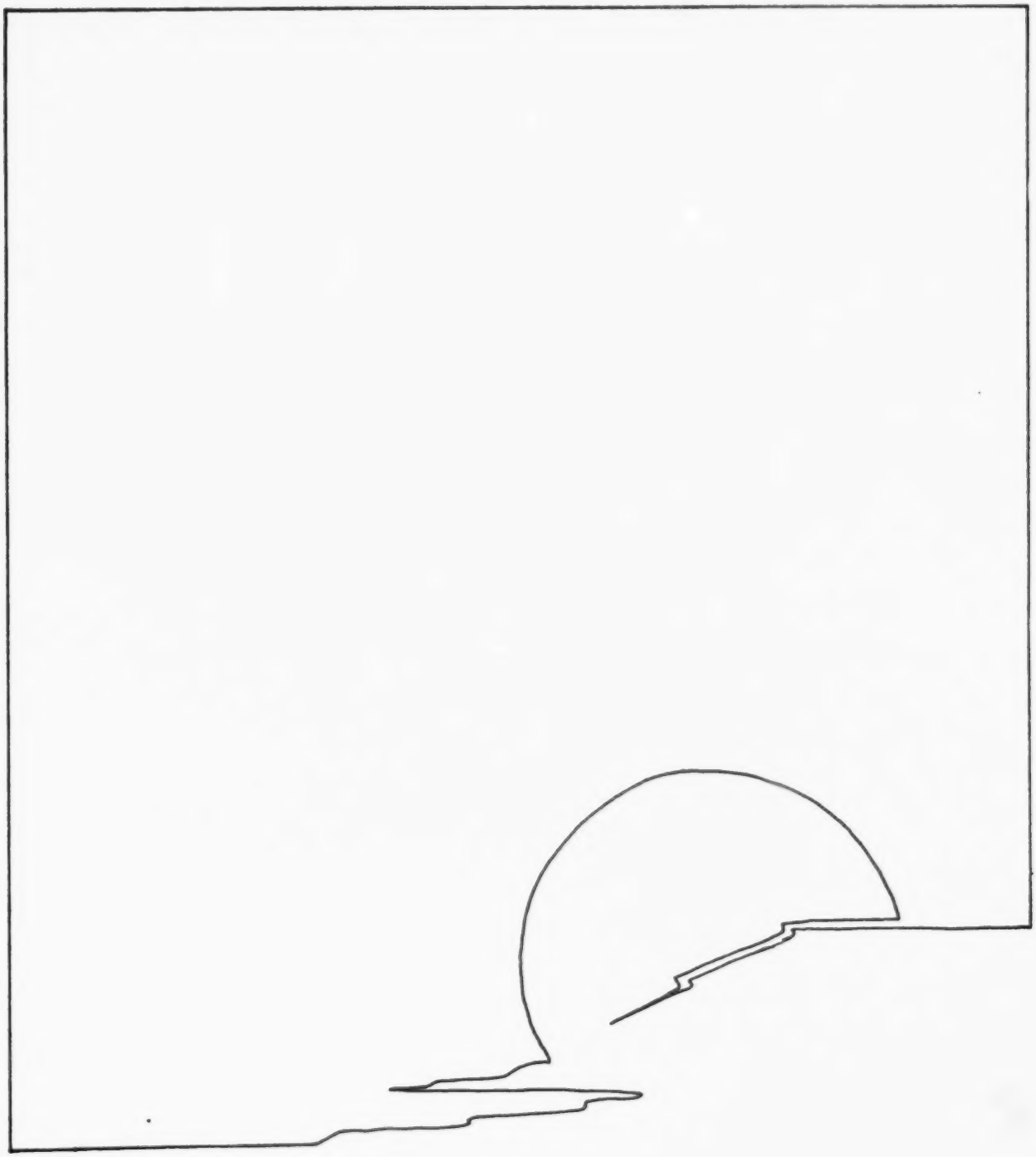
Everyone is familiar with the feline fear of water. This cat rushes to escape the incoming wave only to be returned to its starting point by the next wave. A treadmill can be connected to an electrical generator to supply electricity.

Teacher Information Sheet - Overhead Transparency

"Dipping Bird"



ONE SOLUTION TO PROJECTED ENERGY NEEDS FOR WASHINGTON STATE



# ACTIVITY 6:
# ENERGY FROM THE SEA—ALTERNATIVES
# (1-2 days)

# ACTIVITY 6: ENERGY FROM THE SEA—ALTERNATIVES (1-2 days)

**CONCEPTS:**

1. There are many pros and cons in using alternative marine energy sources.
2. A tidal power plant generates electricity from turbines run by the rise and fall of the tides.

   Pros: Renewable
   Cons: Need fishladders, locks may be damaged from storms or salt water, not a continuous current--need a way to store the energy.

3. An Ocean Thermal Energy Conversion (OTEC) plant would generate electricity by means of a heat pump utilizing the temperature difference between the upper, warmer waters, and the lower, cooler waters.

   Pros: Renewable; nutrient-rich; cold water is brought to the surface
   Cons: Changes in ecological balance, pollution, need means of delivering the energy.

**OBJECTIVES:**

The student will be able to:
1. Explain some of the ins and outs of generating power from the tides.
2. Explain what an OTEC is and what some of its advantages and disadvantages are.

**TEACHER PREPARATION:**

Make 1 copy for each student of student handouts:
"Tidal Generation"
Map of Puget Sound
"OTEC"
Read Teacher Information Sheet, "Seattle City Light Energy Alternatives for Puget Sound"

**MATERIALS:**

Student worksheets and teacher's copies of "Tidal Generation" and "Ocean Thermal Energy Conversion."
Map of Puget Sound
Teacher Information Sheet - "Seattle City Light Energy Alternatives for Puget Sound"

**PROCEDURES:**

Pass out worksheets and map to be read and filled out individually. You may prefer to use these as homework or independent assignments. Discuss worksheets, making sure that both positive and negative aspects of use of tidal and thermal power come out in the discussion. Bring up ocean currents and windmills at sea as well.

Use Teacher Information Sheet, "Seattle City Light Energy Alternatives for Puget Sound," for background information.

**EXTENDED ACTIVITIES:**

1. Compare tide chart and maps of coastlines to find a good location for a tidal power plant.
2. If you and your students desire a deeper understanding of an OTEC operation, try these demonstrations to show the underlying scientific principles:

a) Set up an ocean with thermal differences:
   1. Fill 2/3 of a plastic tank with room temperature water.
   2. Poke a few holes in the lid of a baby food jar, fill it with crushed ice and a few drops of food coloring.
   3. Cap the jar and set it upright in the tank.
   4. Observe the movements of colored water and take the temperature at different levels in the tank.

Model Steam Engine:

b) Make a model steam engine:
Instead of water, OTEC would use ammonia, propane, or some other liquid with a lower boiling point than water. The principle is the same, however.
Construct the model using the directions from Energy and Man's Environment, page 21.

   1. Demonstrate principles.
      a. When water boils, it expands, forcing steam out of the flask.
      b. Steam under pressure, aimed or concentrated can do work (turning wheel).
   2. Sketch process where this "steam engine" is performing useful work.
   3. Discuss that energy must be used to boil the water. Other methods of providing the energy are fossil fuels, geothermal, solar (concentrating solar energy on water container.)

Film: Tidal Power - 16 mm, 22 minutes. Obtainable on free loan from:
Division Engineer
U.S. Army Engineer Division, New England
424 Trapello Road
Waltham, Massachusetts 02154

**BIBLIOGRAPHY:**

Seattle City Light (Engineering Division). Power Generation Alternatives. Cone Heiden Corporation: Seattle, Washington, 1972. ($5.00)

Cohen, Robert. "Ocean Thermal Energy Conversion." Edited by M.G. Morton. Energy and Man: Technical and Social Aspects of Energy. IEEE Press et al. Eco Science: Population, Resources, Environment. W.A. Freeman and Co.: San Francisco, California 1977.

Davitian, Harry and McLean, William. "Power, Fresh Water and Food From the Sea." Science 184 (May 31, 1974): 938.

Popular Science. "Energy From the Sea." Parts I, II, and III. (May, June, and July, 1975).

Swann, Mark. "Sea Thermal Power." Oceans. (March-April, 1976): 30-35.

National Science Teachers' Association. Solar Sea Power, fact sheet #6. National Science Teachers' Association: 1742 Connecticut Avenue N.E., Washington, D.C. 20009.

TEACHER INFORMATION SHEET

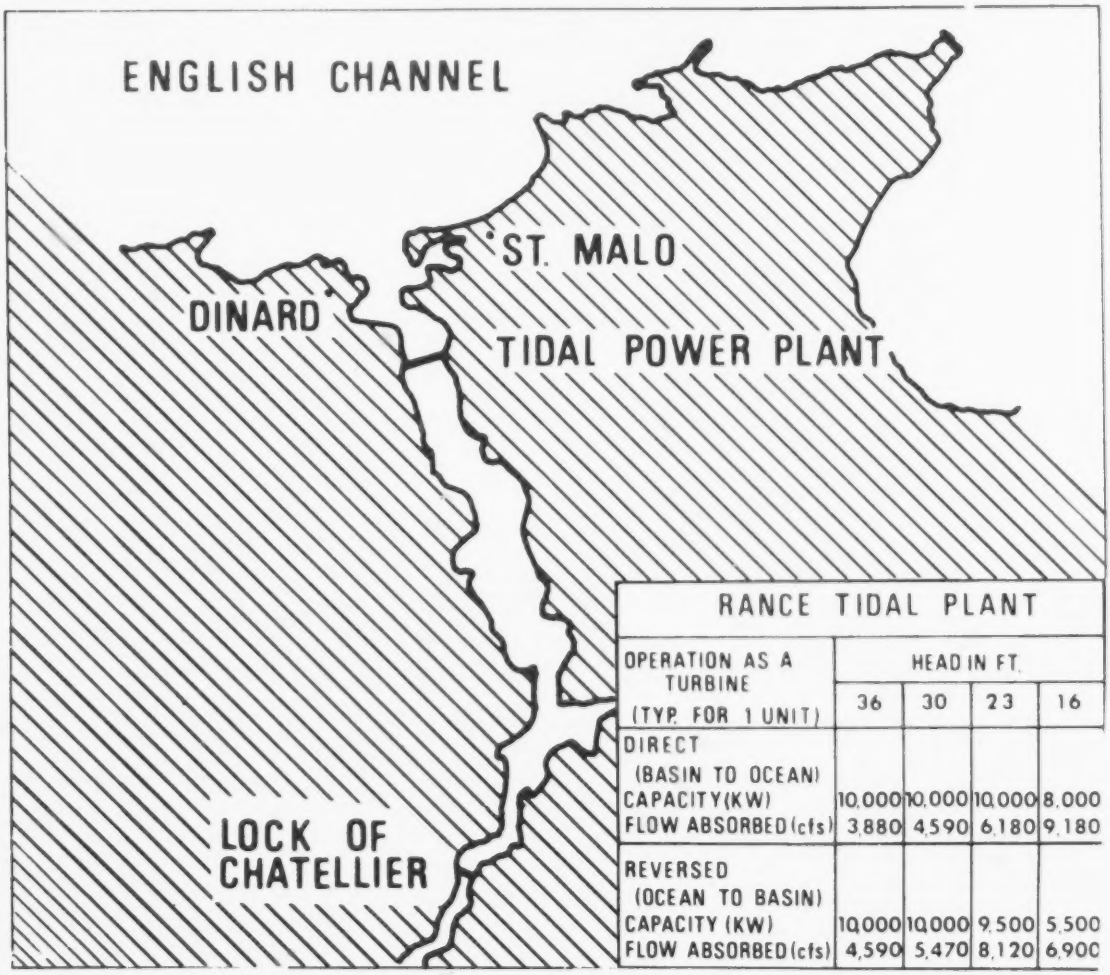
Tidal Generation

Energy Education "Believe It" *

In the Bay of Fundy (Maine), the tides rise as much as 50 feet! A tidal generating plant, if built, could yield 7½ billion KWH - enough to provide power to 700,000 homes!

The daily in and out motion of the ocean tides offers a source of energy that has been used for centuries to run tidal waterwheels throughout the world. Since the plants operated in sequence with the tides, the power was not continuously available, and few developed countries still use them. Means of storing the energy between tides are now available, and the idea of tidal power is regaining popularity.

The world's only large-scale tidal power plant is at the mouth of the Ranee River in France. A dam spanning the estuary (river mouth) encloses a turbine able to run in either direction and includes a lock for passage of ships.

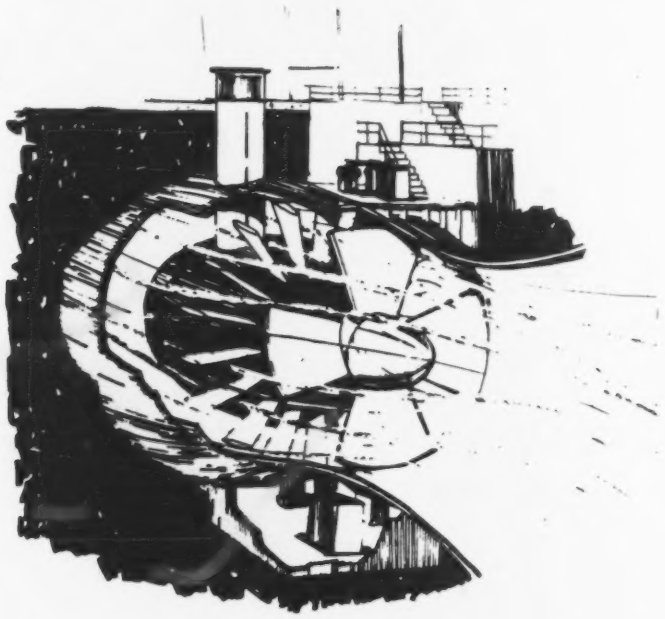



RANCE TIDAL PLANT

| OPERATION AS A TURBINE (TYP. FOR 1 UNIT) | HEAD IN FT. | | | |
|---|---|---|---|---|
| | 36 | 30 | 23 | 16 |
| DIRECT (BASIN TO OCEAN) | | | | |
| CAPACITY (KW) | 10,000 | 10,000 | 10,000 | 8,000 |
| FLOW ABSORBED (cfs) | 3,880 | 4,590 | 6,180 | 9,180 |
| REVERSED (OCEAN TO BASIN) | | | | |
| CAPACITY (KW) | 10,000 | 10,000 | 9,500 | 5,500 |
| FLOW ABSORBED (cfs) | 4,590 | 5,470 | 8,120 | 6,900 |

TEACHER INFORMATION SHEET (cont'd)

Tidal Generation



To be worth building, a tidal power plant must be located in a dammable bay or estuary that has a large difference between high and low tides.
Mark on the map of Puget Sound what you think might be a suitable location for a tidal power plant.

1. *Suitable bay and estuaries in terms of geography circled--warn students that it doesn't consider tide difference etc.--Puget Sound not suitable in these terms. Also, there is too much boat traffic for a convenient location of another lock.*

What positive and negative effects would such a plant have?

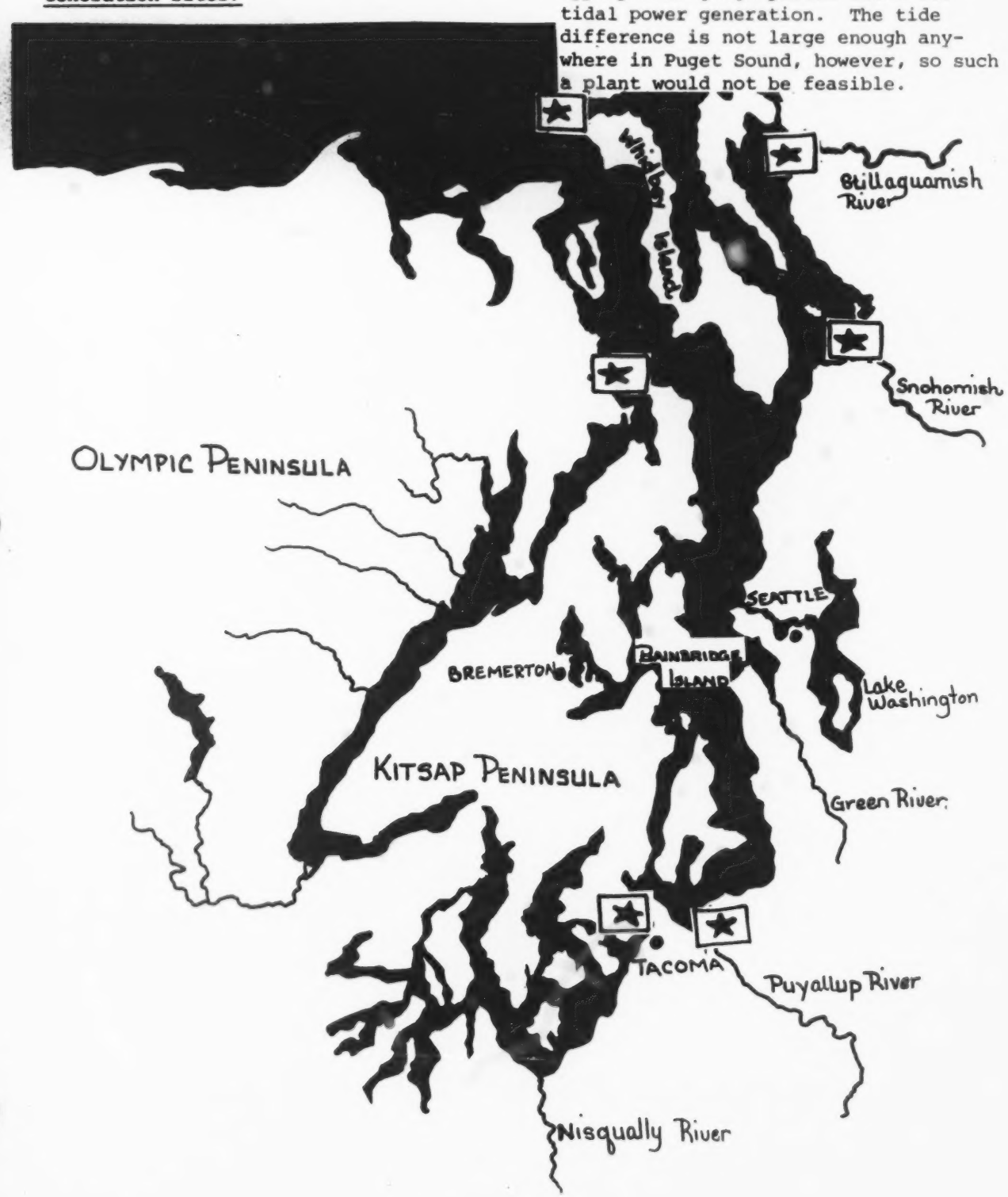
| *Positive* | *Negative* |
|---|---|
| *Renewable Source* | *Not a continuous energy source* |
| | *Need some way of storing energy* |
| | *Need locks if along waterway* |
| | *Need fish ladders* |
| | *Visual pollution* |
| | *Salt water corrodes equipment* |
| | *Possible damage from storms* |

* America's Marine Heritage, Book 1, Heitzmann, p. 19

TEACHER INFORMATION SHEET (cont'd)

**Map of Puget Sound - Possible Tidal Generation Sites?**

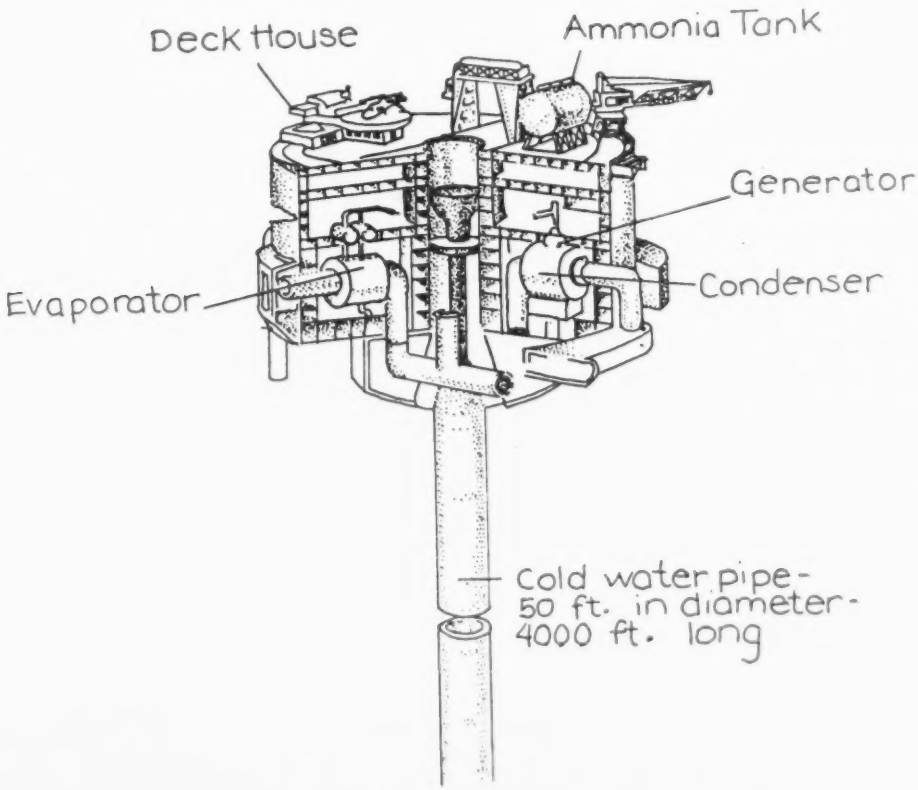
Some estuaries and inlets starred as appropriate geographical sites for tidal power generation. The tide difference is not large enough anywhere in Puget Sound, however, so such a plant would not be feasible.



TEACHER INFORMATION SHEET

## OCEAN THERMAL ENERGY CONVERSION (OTEC)

A tremendous amount of solar energy is stored in the warm surface waters of the tropical and subtropical ocean. Beneath these waters are layers of cold water that came from the melting polar ice caps. It has been proposed that the temperature difference between these layers could be used to generate electricity, and the Energy Research and Development Administration is funding research on OTEC. One proposed site is part of the Gulf Stream which flows in a path about 20 miles wide and 500 miles long along Florida's Atlantic Coast. OTEC units such as the one pictured here, spaced a mile apart, could produce $26 \times 10^{12}$ kw-hours per year - 15 times the total U.S. consumption of electric power in 1975.*




from National Science Teachers Association factsheet #6, Solar Sea Power

TEACHER INFORMATION SHEET (cont'd)

Ocean Thermal Energy Conversion (OTEC)

1. What do you think of the possibilities for OTEC electricity in the Pacific Northwest?

   *All answers acceptable - but point out:*
   *Ocean waters are not tropical this far north - there is not enough of a a temperature difference to be worthwhile.*

2. One major problem of the OTEC idea is that the site would be far away from where the electricity is needed. How would you solve the problem of getting the electricity to population areas?

   1. *Submerged cables to transmit power to populated areas.*
   2. *Use power at the site to make an energy intensive product such as hydrogen or aluminum which can be shipped.*
   3. *Move people to the site.*

3. OTEC plants could have a variety of effects on their immediate environments. Pumping up the deeper cool waters would bring unused nutrients up to the surface and could enrich ocean life around the stations, but would change the balance of life (ecology). Equalizing the temperature differences would also have an effect on the ecological balance of the surrounding waters. What advantages and disadvantages do you think this form of energy has?

   *Advantages*

   *Renewable energy resource*
   *Technology not worked out completely, but much is available from other marine endeavors.*
   *Changes in ecological balance*
   *Richer nutrients brought up by cold water*

   *Disadvantages*

   *Hard to deliver energy*
   *Interference with shipping*
   *Unsightly*
   *Technology not worked out completely, but much is available from other marine endeavors.*
   *Cost unsure*
   *Expensive capital costs*
   *Possible spillage of fluid used*
   *Corrosion of equipment*
   *Changes in ecological balance*

STUDENT HANDOUT

NAME _____

DATE _____

PERIOD _____

Tidal Generation

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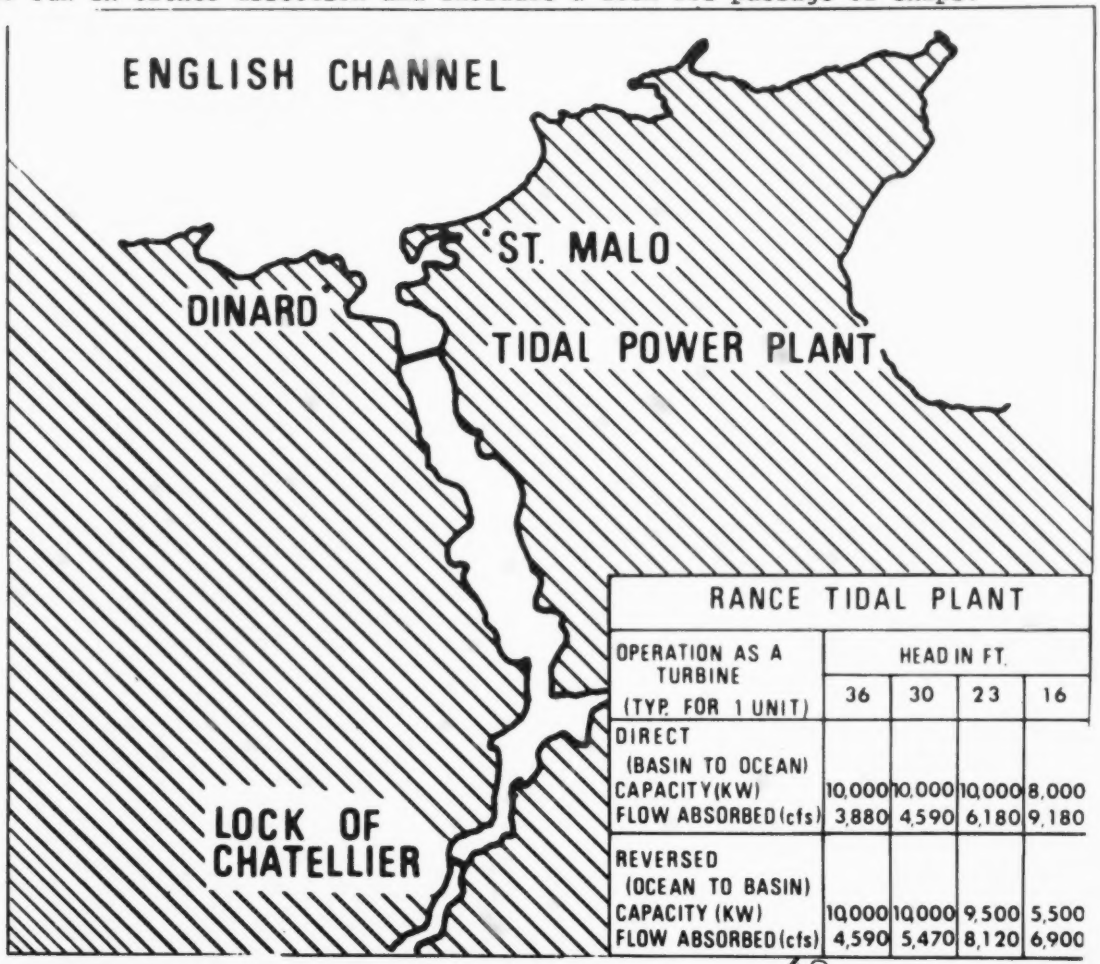


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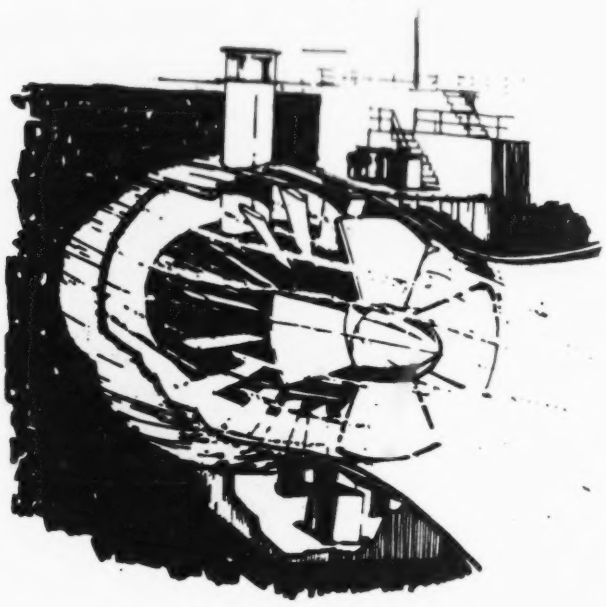
STUDENT HANDOUT (cont'd)

NAME_____

DATE_____

PERIOD_____

Tidal Generation



To be worth building, a tidal power plant must be located in a dammable bay or estuary that has a large difference between high and low tides. Mark on the map of Puget Sound what you think might be a suitable location for a tidal power plant.

What positive and negative effects would such a plant have?

Positive

Negative

* America's Marine Heritage, Book 1, Heitzmann, p. 19

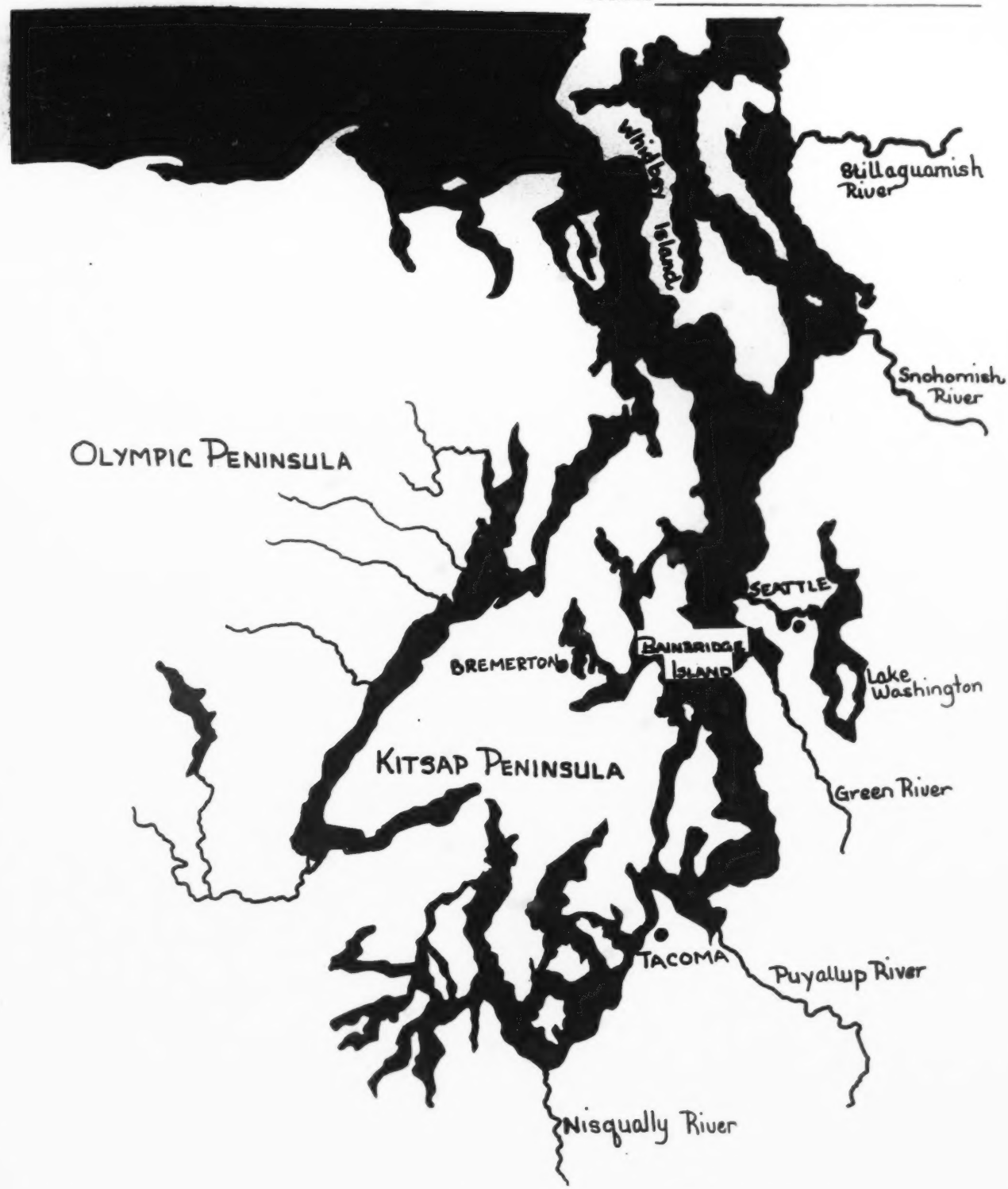
STUDENT HANDOUT

NAME _____

DATE _____

PERIOD _____

**Map of Puget Sound**



STUDENT HANDOUT

NAME _____

DATE _____

PERIOD _____

## OCEAN THERMAL ENERGY CONVERSION (OTEC)

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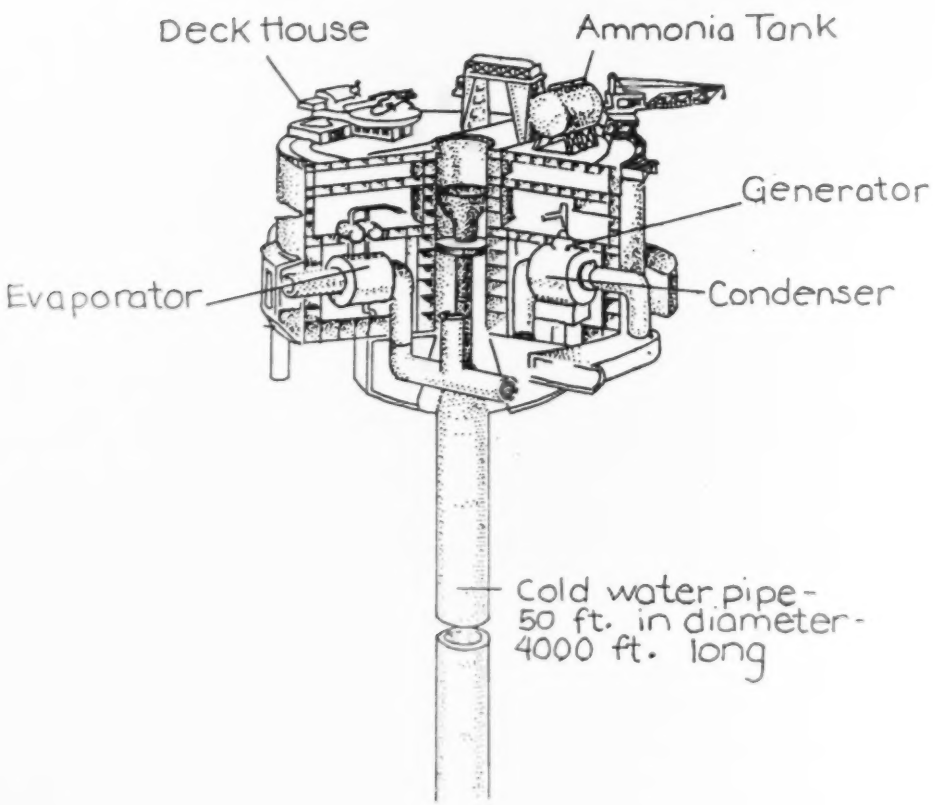



*from National Science Teachers Association factsheet #6, Solar Sea Power

STUDENT HANDOUT (cont'd)

NAME_____

DATE_____

PERIOD_____

Ocean Thermal Energy Conversion (OTEC)

1. What do you think of the possibilities for OTEC electricity in the Pacific Northwest?

2. One major problem of the OTEC idea is that the site would be far away from where the electricity is needed. How would you solve the problem of getting the electricity to population areas?

3. OTEC plants could have a variety of effects on their immediate environments. Pumping up the deeper cool waters would bring unused nutrients up to the surface and could enrich ocean life around the stations, but would change the balance of life (ecology). Equalizing the temperature differences would also have an effect on the ecological balance of the surrounding waters. What advantages and disadvantages do you think think this form of energy has?

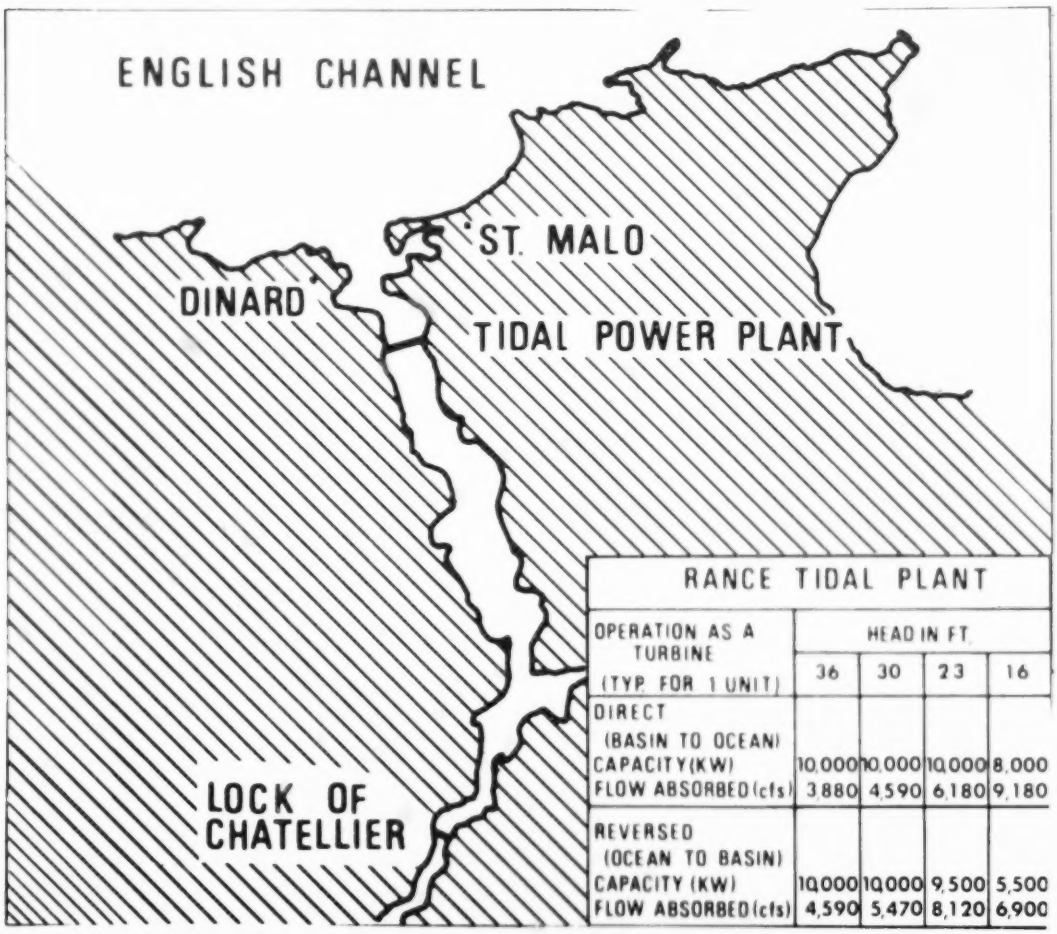
TEACHER INFORMATION SHEET

"Seattle City Light: Evaluation of Alternative Energy Sources for Puget Sound"

TIDAL POWER has been used for centuries to run tidal waterwheels along bays and estuaries of Europe and North America. The operation of these plants was in sequence with the tide cycles and consequently operation of tidal mills which they drove was not continuous. As steam and gas engines developed with rapid industrialization, the use of tidal mills gradually declined until they are now primarily used in underdeveloped countries.

Power demands nowadays dictate the period of the day that electricity must be made available. Tidal power unfortunately is only available during lunar-solar tide peaks which do not coincide with the normal morning and evening peaking demands. It is also very difficult to harness effectively because available head is generally small and varies from day to day and from season to season.

Potential tidal power plant sites have been studied extensively for the past seventy years. A few promising sites have been found along the coastal regions of France, Africa, Australia, and the Northeastern Seaboard of the United States. During all these years of site study only one plant, France's Rance Tidal Plant, has been built.




RANCE TIDAL PLANT

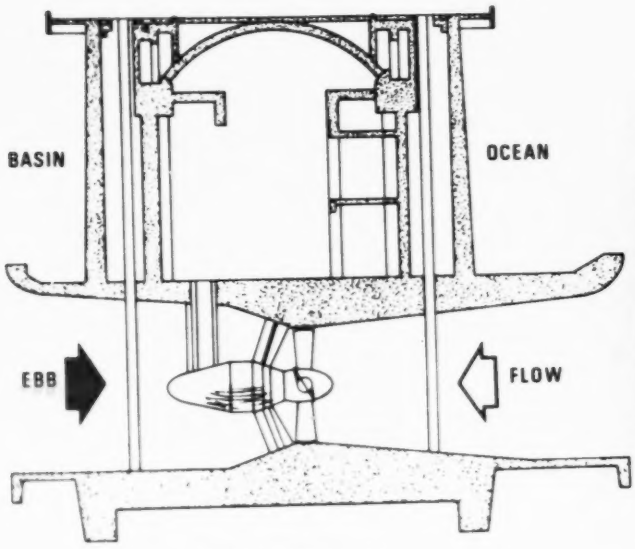
| OPERATION AS A TURBINE (TYP. FOR 1 UNIT) | HEAD IN FT. | | | |
|---|---|---|---|---|
| | 36 | 30 | 23 | 16 |
| DIRECT (BASIN TO OCEAN) | | | | |
| CAPACITY (KW) | 10,000 | 10,000 | 10,000 | 8,000 |
| FLOW ABSORBED (cfs) | 3880 | 4590 | 6180 | 9,180 |
| REVERSED (OCEAN TO BASIN) | | | | |
| CAPACITY (KW) | 10,000 | 10,000 | 9,500 | 5,500 |
| FLOW ABSORBED (cfs) | 4,590 | 5,470 | 8,120 | 6,900 |

TEACHER INFORMATION SHEET (cont'd)

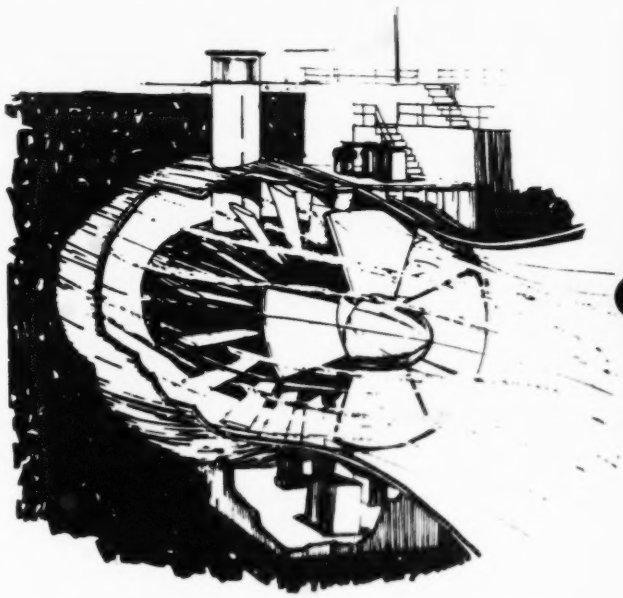
"Seattle City Light: Evaluation of Alternative Energy Sources for Puget Sound"

Tidal hydroelectric power generation is similar to river hydroplants, but tidal plants are much more complex and require significantly more operation of gates, equipment and controlling devices.

Tidal dams are built across bays or estuaries to impound seawater in a basin to create head. The enclosed basin is allowed to fill during the incoming tide with part of the incoming flow passing through hydraulic turbine-generators. When the tide reaches its highest level all gates and hydraulic turbines are shut down. The outgoing tide recedes, causing a head differential between the sea and the impounded seawater. When the head is sufficient, seawater from the basin is allowed to run out to sea through the hydraulic turbine-generators. A single basin of this type, utilizing sea flow in both directions, is commonly called a two-way tidal plant.




TIDAL GENERATOR



Control of the filling and emptying operations of a tidal plant requires many moving gates which operate on a daily cycle. These operations, complicated by the rapidly varying head and salt water corosion, add to overall plant cost.

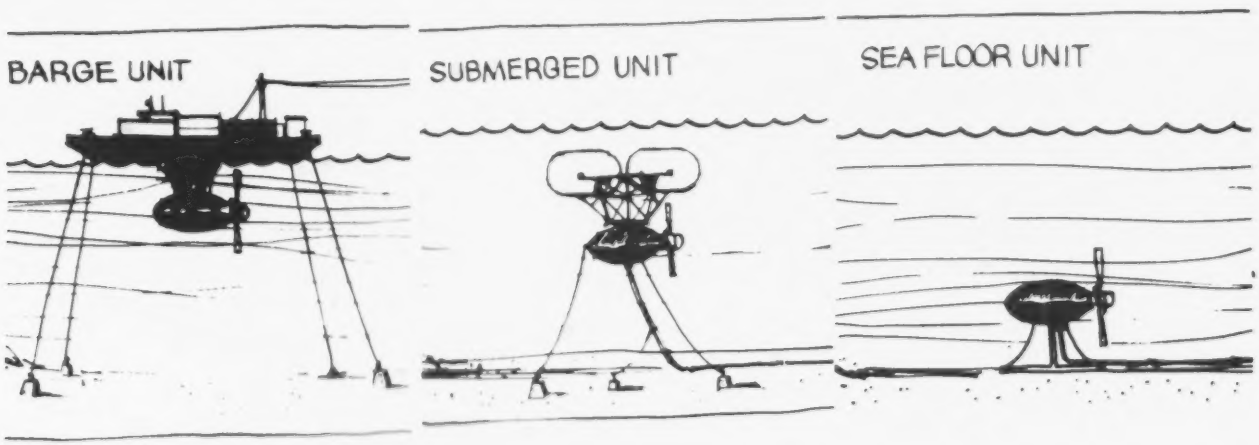
The Rance Plant is the most celebrated tidal plant in existence. Nearly 15 years of study, model research and detailed planning were necessary to complete this plant. The Rance estuary lies between the towns of Dinard and St. Malo, in Northwestern France. The enclosed estuary impounds approximately 5400 acres of seawater. The project consists of a 2500 foot long dike, locks, movable barrages, power station, and reversible bulb-turbines. A cross-section of the dike shows the location of a bulb-turbine in a conduit tunnel. The dike was designed to be symmetrical so that it would resist seawater pressure from both directions. The interior of the bulb-turbine pod contains an electric generator. Struts project radially to the walls of the conduit tunnel to support the bulb. One of the struts is large enough to permit a man to enter and service the generator in the interior of the bulb. The most distinguishing feature of the bulb-turbine is its ability to run in both directions, either as a generator of electricity when seawater runs through the units or as a pump when supplied with electric power. If power is supplied to the turbine-generator, the generator becomes a motor and the turbine blades act

as a pump forcing water through the conduit. The overall plant efficiency is improved by using the turbine-generators as pumps during the periods of slack water at high and low tides. This method increases both the volume of usable seawater and overall head. The net gain, even after using electrical energy for pumping, is considerable. Each turbine generates a maximum of 10,000 kilowatts or a total rated on-line capacity of 240,000 kilowatts for twenty-four units. The total annual output is about 670 million kilowatt hours.

The energy derived from the tides is free like hydroelectric power, but not as continuous. Even considering the interruptions of power production during tide cycles, a tidal plant's overall costs may be competitive with some fossil fuel plants since there are no expenditures for fuel. However, this is only true for those regions having tides of exceptional amplitude and basin capacity.

The potential of tidal power in the Pacific Northwest is not promising. Many bays along the coast or on Hood Canal are marginally suited to tidal plants, but costs to build and run such facilities would far exceed comparable nuclear, fossil fuel or hydroelectric facilities. The environmental impact of a tidal plant facility depends upon the locale. If an estuary has heavy waterway traffic, locks would be necessary. If the estuary contained fish-producing streams, fishways and fish ladders would have to be provided. Visual pollution would be a problem if the bay or estuary was resort oriented.

OCEAN CURRENT POWER, although theoretically a feasible method of generating electricity, has yet to be demonstrated. Three concepts of ocean current generators are shown: a floating barge unit, a submerged unit, and a sea floor unit.




The mobile floating barge unit could be moved from site to site. The turbine-generator pod would be mounted from the bottom of the barge with access for servicing provided through the hollow supporting strut. All supporting equipment, controls, monitoring and transmission lines would be located on the barge deck with directional control of the turbine accomplished by mechanical control from the control room at deck level.

TEACHER INFORMATION SHEET (cont'd)

"Seattle City Light: Evaluation of Alternative Energy Sources for Puget Sound"

The submerged turbine-generator pod unit, like the barge unit, would be very flexible, since the anchoring lines could be moved to transfer the pod unit from site to site. Bouyancy would be provided by pressurized air cylinders. The unit would be tethered to automatically orient itself with changes in current direction and would run unattended. All transmission lines would be run along the ocean bottom to a land-based central receiving station.

The sea floor current generator unit would be the least flexible of the three methods since site-to-site transfer would be difficult. All transmission lines for this unit would run along the ocean floor to shore. Directional control of this unit would be difficult, so the unit would be oriented in the most favorable current direction.

Any one of the underwater units mentioned could be used for application as auxiliary power units for underwater aqua-farming communities, underwater research laboratories, and underwater mining operations, but to utilize an underwater pod-turbine effectively, the units would have to be placed in or near shallow coastal regions where current flow is of sufficient power and strength and transmission distance short.

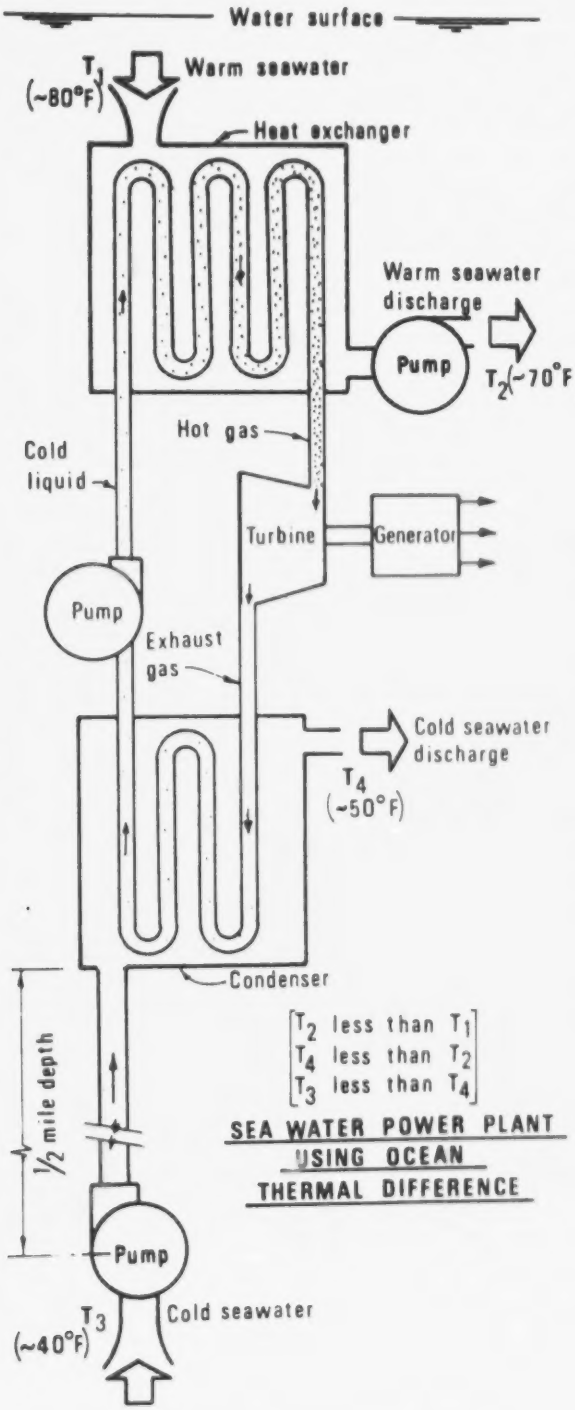
All the underwater concepts for generating electricity that have been described are similar in design and operation. All would use a bulb turbine-generator pod design. Blading for these pod units would be very large.

The disadvantages of underwater generating devices are the cost penalties incurred as the result of transmission losses and difficulties in maintaining feeder transmission lines to shore.

The floating barge unit, the submerged pod unit, and quite possibly even the sea floor unit would all interfere with surface and subsurface ocean traffic. Special warning devices would be required on the barge units and beacon buoys would be required on submerged units. The environmental problems caused by these devices would be minimal if only a few were located at one site. If a large number of units were placed in coastal waters, current shift could possibly occur and marine life and oceanographic conditions in the area could be affected. It is very unlikely that large scale electric power generation using ocean currents will be seriously considered in the near future.

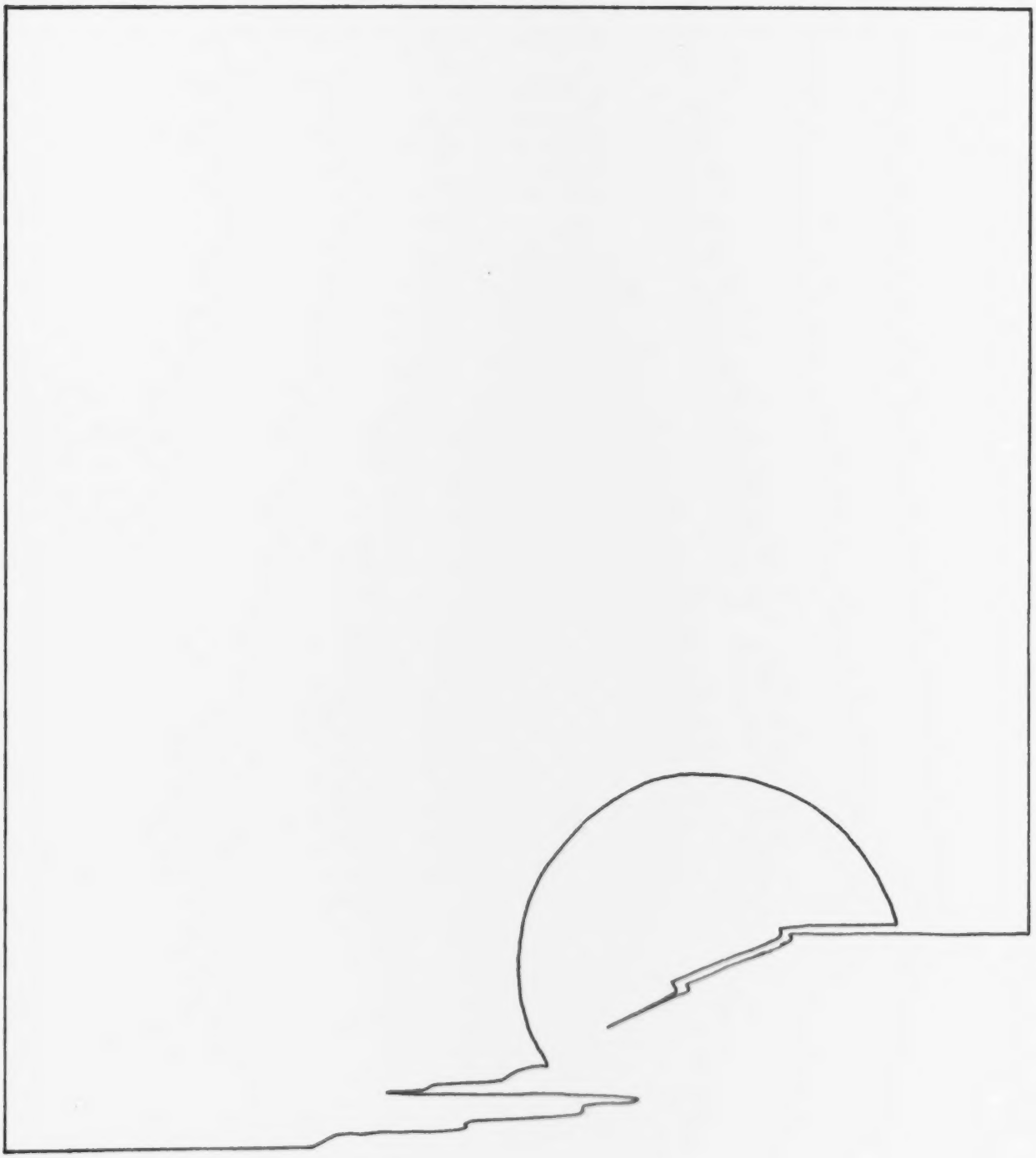
OCEAN THERMAL power schemes date back to the 1800's when the French physicist, Professor D'Arsonval, proposed generating power from the temperature difference between the ocean surface and deep sublayer. His scheme was to use cold, deep ocean seawater for condenser water and warmer surface seawater to heat a boiler containing a working fluid of very low boiling point so that vaporization would occur under normal atmospheric pressure. The vaporized gas was to then pass through a conventional steam engine to produce power, following which it was to be condensed in the condenser and then pumped back to the boiler as a liquid for reuse in the cycle. Several such schemes have been tried on a small scale but none have achieved complete success because of on-site difficulties and technical problems. One of the drawbacks of any ocean or seawater thermal plant is the friction loss incurred by using long runs of pipe to reach cold ocean water.

"Seattle City Light: Evaluation of Alternative Energy Sources for Puget Sound"




One of the more popular closed-cycle schemes uses propane as the working fluid for a turbine-generator combination. A very simplified schematic shows how heat from warm ocean seawater is supplied to a boiler to convert liquid propane to a vapor which is then used to drive a turbine-generator. The exhaust propane gas from the turbine is converted back to a liquid in the condenser by cold seawater pumped from lower depths. Pumps recycle the liquid propane back to the boiler for reuse. Although the method described is very simple, extensive engineering is required to build efficient and durable heat exchangers. A power plant using such a cycle could be on land, on a floating ocean platform, or completely submerged. The thermal efficiency of such a plant using a 40 degree Fahrenheit temperature difference would be less than 7 percent and, therefore large quantities of seawater and large equipment would be required to obtain small amounts of energy. The environmental effects of such a plant are quite obvious since its location on the sea or in the sea would likely interfere with ocean transportation, fisheries, and sea life. In addition if several large plants were used, the colder seawater would be warmed by heat from the plant and could, therefore, influence the natural ocean circulation.

To date, no large scale ocean thermal plant has been constructed and therefore costs are uncertain.



# ACTIVITY 7:
# ENERGY FROM THE SEA
# (1 day)

# ACTIVITY 7: ENERGY FROM THE SEA (1 day)

**CONCEPTS:** Decisions concerning our energy sources and usage should be made considering all the economic, environmental and technological aspects.

**OBJECTIVES:** The student will be able to:
1. Name some factors which should be made considering all the economic, environmental and technological aspects.
2. Evaluate an energy source on the basis of those factors.

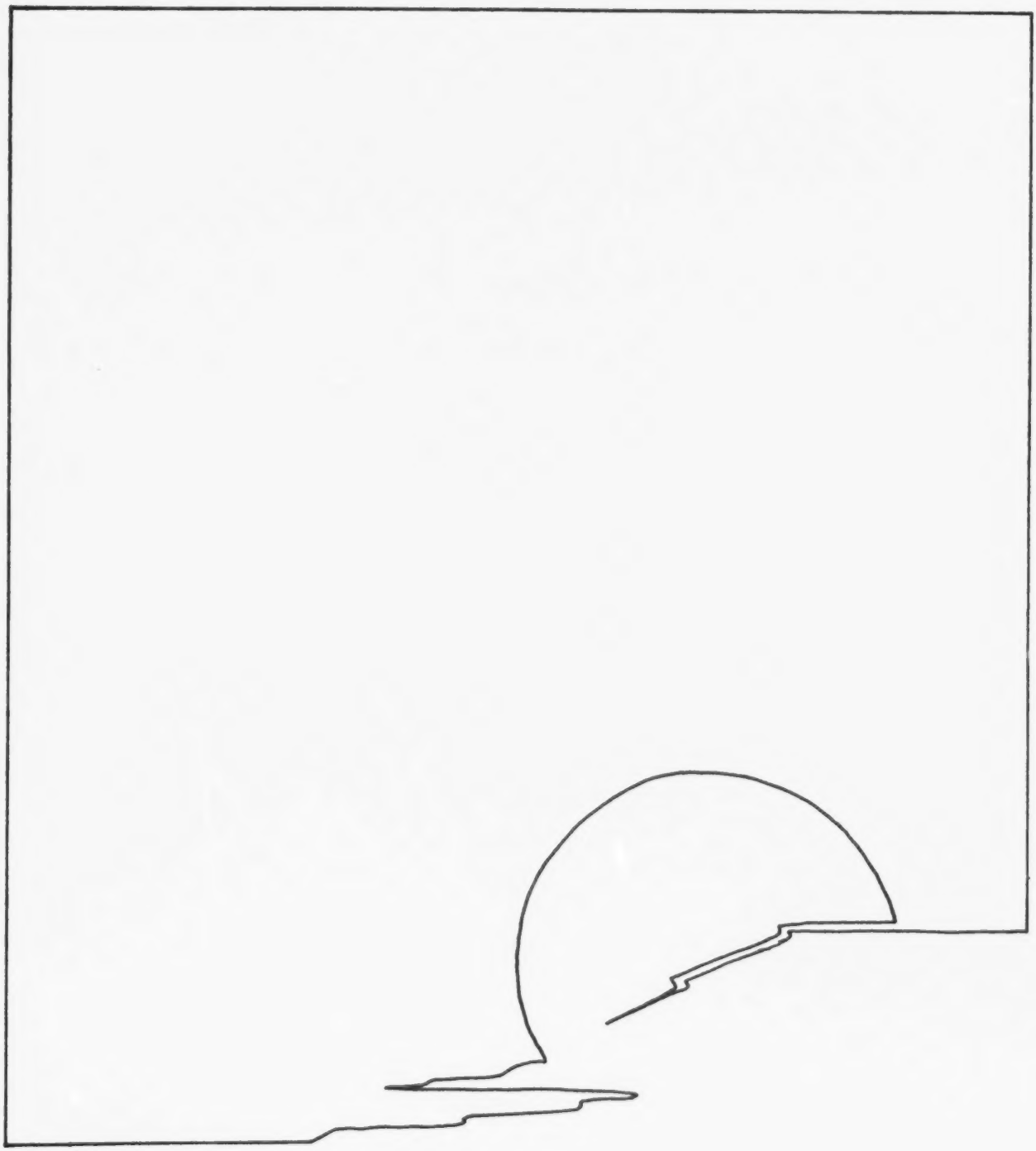
**TEACHER PREPARATION:** We suggest you read teacher background information sheet "Seattle City Light Energy Evaluation Alternatives for Puget Sound".

**PROCEDURES:** Announce that each student is to select which ocean energy source s/he thinks is most suitable and to be ready to defend that choice on the basis of these criteria:
(to be written on board or overhead)

A perfect fuel would:

1. be unlimited in supply.
2. be located (the supply) close to where it is needed.
3. present no technological problems.
4. be highly efficient.
5. present no aesthetic problems.
6. have no adverse impact on the environment.
7. have minimal cost.

Encourage students to discuss disagreements with each other and come up with their own ideas as to possible environmental impact, technological problems, etc. You as the teacher can act as the resource person to offer extra factual information. (Keep in mind that the teacher handout, while it is an evaluation of alternatives specifically for this area, has the built-in bias of the utility company.)



**EVALUATION**

**VOCABULARY**

**BIBLIOGRAPHY**

# ENERGY FROM THE SEA

## EVALUATION:

The first student handout "Energy from the Sea" presents ten questions dealing with the material in Energy from the Sea. Providing the students with a copy on the first day will make it clear what concepts are important for them to become acquainted with. The questions will make a good evlautive instrument as well. Numbers 3, 4, 8, 9 and 10 along with the following, more thought-provoking essay question should give you a good idea about how well the activities got the point across.

Imagine that you are a resident of a small fishing town on the Bay of Funday in Maine. The U.S. Army Corps of Engineers has decided to build a tidal power plant across the inlet to the town's harbor which features an average 15 foot difference between mean high and low tide. A town meeting is held allowing citizens, experts and army corps personnel to voice their opinions. There is great controversy surrounding the project. Among those making statements are a fisherman, the owner of a private campground on the inlet, the president of the Chamber of Commerce, the president of the local power company whose personal fortune is founded in coal, and an expert on alternative energy sources brought in from out of town. Describe what you think each of their statements might be, and their point of view concerning the tidal power plant.

# ENERGY FROM THE SEA

## VOCABULARY:

1. Electricity - energy derived from electrons in motion.
2. Energy - the capacity to perform work such as making things move.
3. Fossil Fuels- fuels derived from the fossil remains of organic materials. Includes petroleum, natural gas, coal, oil shale and tar sands.
4. Geothermal Energy - heat energy within the earth's outer crust.
5. Hydroelectric Power - electricity generated using moving water.
6. Solar Energy - radiant energy directly from the sun.
7. Law of Diminishing Returns - more energy is required to recover the remaining resources as the resource is used up.
8. Renewable Energy Source - an energy source that can be used over and over, that does not deplete a fuel supply.
9. Non-Renewable Energy Source - a fuel of which there is a fixed supply
10. Nuclear Power - energy derived from splitting (fission) or fusion of atomic nuclei.
11. OTEC - ocean thermal energy conversion. This new process would generate electricity by means of a heat pump acting across the temperature difference between the upper, warmer waters, and the lower, cooler waters of the ocean.

# ENERGY FROM THE SEA

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